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# INSTRUCTION MANUAL

# MODEL 850T/855T/853T

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

**California Instruments**

5150 Convoy Street San Diego, CA 92111-1266 (619) 279-8620 Telex 695047

California INSTRUMENTS

REVISION J
January 1987

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P/N 4855-960

# INSTRUCTION MANUAL

# MODEL 850T/855T/853T

Invertron®

## NOTE:

ASSEMBLIES, SCHEMATICS AND PARTS LISTS MAY DIFFER FROM THIS MANUAL IF MODEL NUMBER HAS A 3 OR 4 DIGIT SUFFIX. SEE SERIAL NUMBER TAG FOR PROPER IDENTIFICATION.

EXAMPLE

849TA-1-4-2-8-1-3888

MODEL NUMBER

OPTIONS ( IF APPLICABLE )

4 DIGIT SUFFIX

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# SECTION I—DESCRIPTION

## 1.1 INTRODUCTION

This instruction manual contains information relative to the installation, operation, calibration and maintenance of California Instruments 850T/855T Series Precision Oscillators. A detailed theory of operation is provided as an aid for maintenance personnel. A complete parts listing, schematic and component location diagrams are also supplied.

## 1.2 MODEL NUMBER DESCRIPTION

All oscillators in the 850T/855T Series have a five place model number which describes the oscillator series and the number of output phases. In addition, a "D" is placed after the model number if the oscillator is to be used in the three-phase, open delta configuration. The following examples illustrate this numbering system.

Example 1: 850T-1.

This is a variable frequency oscillator with single phase output.

Example 2: 850T-3D

This is a variable frequency oscillator with two-phase 60° open delta output (Phase C leading Phase A).

Example 3: 855T-2.

This is a fixed frequency oscillator with two-phase outputs, 90° displaced. (Phase C leading Phase A).

Example 4: 855T-3.

This oscillator is fixed frequency with three-phase wye output connections.

### NOTE

Although the 855T is designated as a fixed frequency oscillator and will be set to the customer specified frequency, internal switches permit reprogramming the oscillator frequency.

## 1.3 GENERAL DESCRIPTION

California Instruments' 850T Series variable frequency oscillators and 855T Series fixed frequency oscillators are designed to plug into and derive their power from any of the Invertron® AC Power Sources. The output of the oscillator then provides the input frequency and amplitude drive for the Power Source. They employ digital logic techniques for frequency generation with a crystal controlled oscillator serving as the reference for the digital logic circuits. This technique provides long term frequency stability not obtainable with analog circuits. The 850T Series has three frequency ranges selected with a front panel switch. There are four frequency selection controls, permitting precise adjustment of the output frequency with resolution of one part in ten-thousand. Frequency is adjustable in 0.01 Hz steps from 0.01 Hz to 99.99 Hz in the X1 range, in 0.1 Hz steps from 0.1 to 999.9 Hz in the X10 range and in 1 Hz steps from 1 to 9999 Hz in the X100 range. By setting the internal switches and making other minor internal changes to the 855T, its output frequency may be similarly adjusted to any frequency selectable in 1 Hz steps.

The crystal oscillator reference has an average frequency stability of five parts per million per degree Centigrade. Thus, with the frequency having been set at room temperature, the maximum variation would be approximately 125 parts per million (0.0125%) over the 0 to 55°C range. The oscillator frequency is divided by digital logic circuits to the selected output frequency and then filtered to remove harmonic components.

The 850T/855T Series Oscillators will shut down if the frequency is outside of factory set limits. This prevents selection of a frequency outside the operating limits of the associated power source, in the case of the 850T, and protects against a malfunction of the oscillator circuits that would produce a frequency outside these limits.

The 850T/855T Series Oscillators are equipped with a "soft start" feature that slowly increases the output amplitude from zero to the set level whenever the

unit is first turned on. The 850T also "soft starts" when resuming operation after automatic shutdown caused by selection of an out-of-limit frequency.

Both the 850T and 855T Oscillators may be equipped with optional circuit boards to provide two- or three-phase outputs. Additionally, the output phases may be set to any 30 degree increment relative to the reference phase. Because of the digital techniques employed, the electrical angle between phases remains constant irrespective of frequency.

## 1.4 ACCESSORY EQUIPMENT

An Extender Assembly, Part No. 4800-703 is available for use with the 850T/855T Series Oscillators, permitting test and adjustment outside of the associated power source.

## 1-5 SPECIFICATIONS AND PERFORMANCE DATA

Specifications and performance data for the 850T/855T Series Precision Oscillators are listed in Table 1-2. All units are factory tested to these specifications in accordance with California Instruments Division test procedures as detailed in Section V of this manual.

Table 1- . Specifications.

| | |
|---|---|
| FREQUENCY RESOLUTION: | 1 part in 10,000 |
| FREQUENCY ACCURACY: | 0.005% at 23°C |
| FREQUENCY STABILITY: | 5 ppm per °C.Average Temperature coefficient from 0 to 55°C. |
| FREQUENCY RESPONSE: | ±1% from 45 Hz to 1 KHz.<br>±2% from 45 Hz to 5 Khz.<br>±3% from 45 Hz to 10 KHz. |
| AMPLITUDE STABILITY: | ±0.1% for 24 Hrs at 23°C. |
| AMPLITUDE TEMPERATURE COEFFICENT: | 0.02% per °C Average temperature coefficient from 0 to 55°C. |
| TOTAL HARMONIC DISTORTION: | 0.3% max. on 855T and on X100 range of 850T.<br>0.15% on other ranges at full output. |
| PHASE ACCURACY: | |
| Two Phase: | 90° 1° from 45 Hz to 5 KHz.<br>90° 2° from 5 Khz to 10 KHz.<br><br>(Phase C leading Phase A) |
| Three Phase Delta: | 60° 1° from 45 Hz to 5 KHz.<br>60° 2° from 5 KHz to 10 KHz.<br><br>(Phase C leading Phase A). |
| Three Phase Wye: | 120° 1° from 45 Hz to 5 KHz.<br>120° 2° from 5 Khz to 10 KHz. |
| GENERAL: | |
| Size: | Standard Plug-In size for all Invertron® AC Power Supplies. |
| Input Power: | Available from associated Invertron® AC Power Sources. |
| Front Panel Finish: | Gray, 26440 per Federal Standard 595 with black silk screened lettering. |

**CAUTION**

Voltages up to 500 Volts AC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

**DEATH**

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug-in oscillator, the primary power circuits and output circuits of the associated Invertron® if oscillator is tested and/or adjusted with Invertron®.

# SECTION II
# INSTALLATION AND OPERATION

## 2.1 UNPACKING

Individual oscillators are shipped in cardboard containers with protective inner packing. Do not destroy this packing container until the unit has been inspected for possible damage in shipment.

## 2.2 POWER REQUIREMENTS

The California Instruments 850T/855T Series Precision Oscillators operate from +25 volts DC and −25 volts DC at 0.040 amperes. In addition, 115 volts AC at 10 volt-amperes is required. These power inputs are normally obtained from an associated Invertron® power source.

## 2.3 FUSE REQUIREMENTS

Separate fusing of the power sources for the California Instruments 850T/855T Series Oscillators is not required.

## 2.4 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately on receipt. If damage is evident, notify carrier. **DO NOT return an instrument to the factory without prior approval.** If the unit appears to be in good condition, perform the following:

Mount the oscillator in the appropriate rack housing or, otherwise, apply +25 volts DC, −25 volts DC and 115 volts AC to the unit.

### 2.4.1 MODEL 850T SINGLE-PHASE OSCILLATORS

The output of a single-phase oscillator should be variable from 0 to 5.000 volts measured between pins 2 and 8 (ground) of connector J2. There is no upper level adjustment. Frequency should be variable in 0.01 Hz steps from 0.01 Hz to 99.99 Hz with the RANGE switch in the X1 position, in 0.1 Hz steps from 0.1 to 999.9 Hz with the switch in the X10 position and in 1 Hz steps from 1 to 9999 Hz with the switch in the X100 position. When monitored with an oscilloscope, distortion should not be visible. Detailed test procedures are provided in the TEST PROCEDURE section of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

### 2.4.2 MODEL 850T TWO-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to the reference phase of these oscillators. The phase C ($\phi$C) output, measured between pins 8 and 9 of J2, should have the same amplitude as the $\phi$A output ( ± 0.05 volts) at any position of the front panel amplitude control. When monitored with an oscilloscope, distortion should not be visible on any phase. Detailed test procedures are provided in Section IV of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

### 2.4.3 MODEL 850T THREE-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to the reference phase of these oscillators. The phase B ($\phi$B) output, measured between pins 7 and 8 of J2, and the phase C ($\phi$C) output, measured between pins 8 and 9 of J2, should have the same amplitude ( ± 0.05 volts) as the A output at any position of the front panel amplitude control. When monitored with an oscilloscope, distortion should not be visible on any phase. When monitored with a phase meter, the angle between the $\phi$B and $\phi$C outputs should be 120°. Detailed test procedures are provided in Section IV of this manual. They should be consulted if further evaluation of the oscillator is required at this time.

### 2.4.4 MODEL 855T SINGLE-PHASE OSCILLATORS

The details of paragraph 2.4.1 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

### 2.4.5 MODEL 855T TWO-PHASE OSCILLATORS

The details of paragraph 2.4.2 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

### 2.4.6 MODEL 855T THREE PHASE OSCILLATORS

The details of paragraph 2.4.3 apply to these oscillators except that the frequency is fixed at that indicated in the manual addendum.

## 2.5 MECHANICAL INSTALLATION AND WIRING

The 850T/855T Series Oscillators fit directly into the California Instruments Solid State Invertron® Series of power amplifiers. All power for the oscillator, as well as signal output(s) is coupled through the printed circuit connector at the rear of the oscillator. Table 2-1 lists the voltages and applicable connector pins.

Table 2-1. Input/Output Connections.

| PIN | FUNCTION |
|---|---|
| 1 | Phase A Output signal low |
| 2 | Phase A Output signal high |
| 3 | Power ground |
| 4 | +25 volt input |
| 5 | −25 volt input |
| 6 | Phase B signal output low |
| 7 | Phase B signal output high |
| 8 | Phase C signal output low |
| 9 | Phase C signal output high |
| 10 | External sync input |
| C | 115 volts AC line high |
| D | 115 volts AC line low |

The single phase versions of the 850T and 855T Series Oscillators have only a $\phi$A output. The two-phase (multiphase) versions have $\phi$A and $\phi$C outputs while the three-phase verisons have $\phi$A, $\phi$B and $\phi$C outputs.

The oscillators require 115 volts AC, which is rectified, filtered and regulated to 5 volts DC for powering the digital circuitry.

## 2.6 OPERATING CONTROLS

The 850T Series oscillators have four frequency selector dials on the front panel with which each digit of the output frequency is individually selected. An AMPLITUDE control varies the output level of all signal outputs from 0 to 5.0 volts. The 855T Series oscillators, being fixed frequency, have only the AMPLITUDE control on the front panel.

The output signals of the multi-phase and three-phase versions of both the 850T and 855T are factory adjusted for equal amplitude of all three phases. The GAIN control on each power amplifier of a multi-phase or three-phase system is used as a trim control to adjust each of the output leg voltages so that they are precisely equal to each other.

### CAUTION

**REMOVE POWER FROM THE SOLID STATE INVERTRON® BEFORE REMOVING OR INSERTING THE PLUG-IN OSCILLATOR.**

# SECTION III
# THEORY OF OPERATION

## 3.1 GENERAL

The California Instruments 850T/855T Series Precision Oscillators, because they are controlled by a quartz crystal, provide a degree of frequency stability that surpasses, by an order of magnitude, that which is obtainable with analog types. Amplitude stability is also improved since the operating frequency is determined by digital logic circuits. Therefore, the basic "oscillator" is not frequency or temperature sensitive. Output amplitude stability will be affected mainly by frequency and temperature as they affect output amplifiers. Such affects are minimal. The optional multi-phase outputs of this series are developed through a single phase to multi-phase converter.

## 3.2 FUNCTIONAL DESCRIPTION

The functional descriptions of this section describe the circuitry of the Model 850T oscillator. The Model 855T operates in exactly the same manner except that the frequency is programmed with internal switches and is not variable at the front panel.

### 3.2.1 PHASE A GENERATOR

#### 3.2.1.1 BASIC OSCILLATOR

The following paragraphs present a functional description of the basic oscillator referenced to the block diagram of Figure 3-1. The crystal oscillator operates at 10.2 MHz. A group of four rate mul-

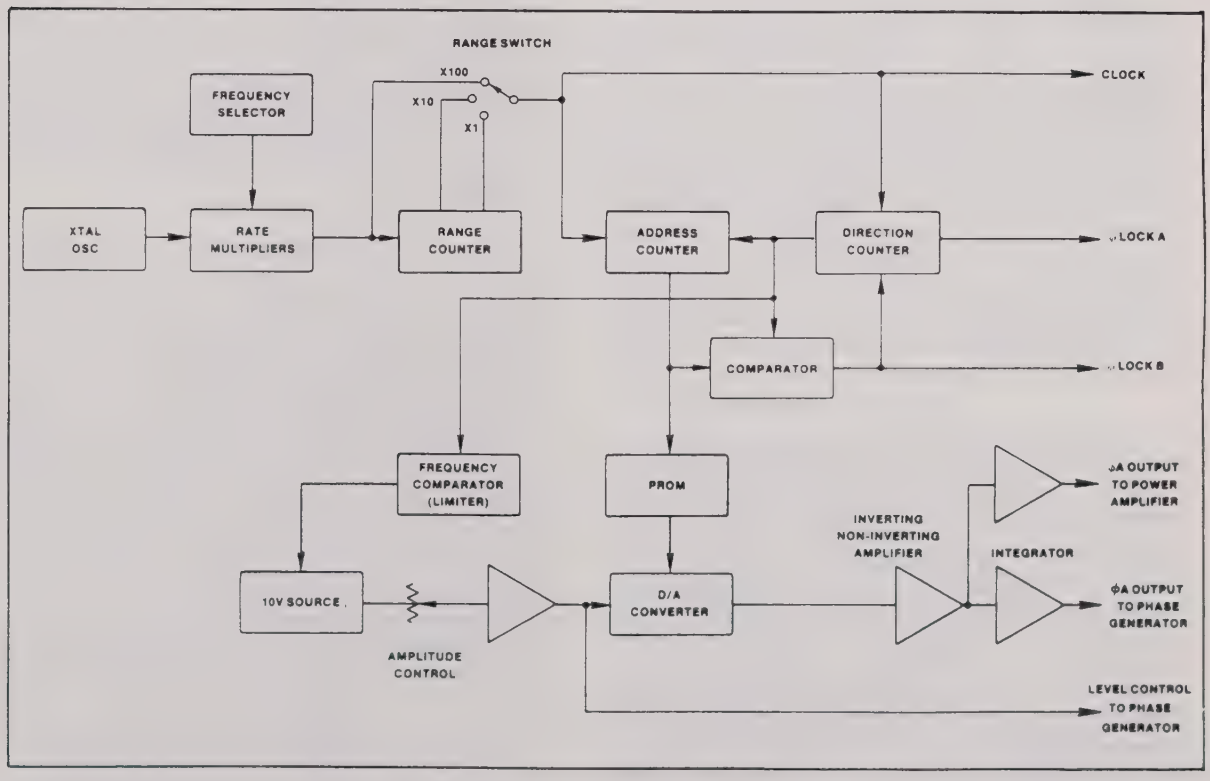



Figure 3-1. Block Diagram, ϕA Generator (Main Board).

tipliers, connected in series, control the number of oscillator pulses that will pass to their output per unit time. That number is dependent on the positions of the four panel rate (frequency) switches to which the rate multipliers are connected. Though not dividers, in the usual sense, the rate multipliers effectively divide the oscillator frequency in accordance with the panel switch settings.

The pulses at the output of the rate multipliers pass to a dual decade counter and the range switch. When the switch is in the X100 position, the rate multiplier output passes through the switch directly to the address counters. When it is in the X10 position, the rate multiplier output is divided by 10 through one half of the dual decade counter before passing to the switch and to the address counters. When it is in the X1 position, it is divided by 100 through both halves of the dual counter before passing to the switch and the address counters. This arrangement permits division of the crystal oscillator by multiplication using factors ranging from 0.001 to 0.9999. The ranges of multiplication, determined by the range switch position, are 0.001 to 0.009999, 0.01 to 0.09999 and 0.1 to 0.9999.

The address counter consists of two binary counters. The four outputs of each counter are connected to inputs of the programmable read-only memory (PROM) which would provide 256 discrete addresses. However, the number of addresses is limited to 255 as the comparator and the direction control counter cause the address counter to change its count mode from up to down at counts 255 and 765 and from down to up at counts 510 and 1020. During each complete cycle, at the output frequency, the counters count up from 000 to 255 for the first 255 clock pulses, count down to 000 during the time of clocks 256 to 510, back to 255 during the time of clocks 511 to 765 and back to 000 during the time of clocks 765 to 1020.

At each of the 255 addresses produced by the address counters, a discrete digital code appears at the output of the PROM and at the input to the digital-to-analog converter (D/A converter). As the address to the PROM progresses from 000 to 255, the PROM output codes cause the output of the D/A converter to increase in 255 steps that describe the first 90 degrees of a sinusoidal waveform. As it progresses from 255 to 000, while the counter is counting down, the second 90 degrees of a sinusoidal waveform are described. The absolute levels at the D/A converter output are determined by the 10 volt reference and the adjustment of the level control.

The waveform at the output of the D/A converter is similar to that of a sinusoidal waveform after full wave rectification except that it is generated in 510 steps (digitally) rather than as an analog signal. To formulate a quasi-sinusoidal waveform, alternate portions of the D/A converter output must be inverted. Alternate clockings of the direction control counter produce a state change at its output that is connected to the inverting/non-inverting amplifier. The state of the counter output determines whether the amplifier will be in its inverting or non-inverting mode. Since the counter output changes state at the end of each half-cycle, alternate half-cycles of the D/A converter output are inverted and the output of the amplifier is a quasi-sinusoidal waveform which is filtered by the integrating amplifier to produce a sinusoidal waveform with very low distortion.

The frequency limiter serves to prevent an output from the oscillator if the selected frequency is outside of the range of the associated power source driven by the 850T. The frequency limits are factory adjusted. The limiter consists of two timers. One limits the upper frequency and the other the lower frequency. The signal that clocks the direction control counter also triggers both sections of the frequency limiter, once for each output cycle. If the frequency is too low, one timer will have timed out before the next trigger pulse occurs. This is sensed and disables the 10 volt reference for the D/A converter, thus shutting off the output. If the frequency is too high, the second timer will not have timed out before the next tigger pulse. This, too, is sensed and also disables the 10 volt reference.

#### 3.2.1.2 MULTI-PHASE OUTPUT GENERATOR

The reference phase, phase A ($\phi$A), is generated by the basic oscillator described functionally in the preceding paragraphs. Phases B and C ($\phi$B and $\phi$C) are generated on an optional second circuit board. The circuits of that board are shown in block diagram form in Figure 3-2. Note that there are similarities between Figures 3-1 and 3-2 in the counter-PROM-D/A converter areas. The address counters are clocked in the same manner as those of the basic oscillator. However, they are preset coincident with the zero degree point of the reference phase, $\phi$A, to a number corresponding to the difference between the reference phase and the desired angle of Phase C ($\phi$C). In the standard unit, this will be the equivalent of 120 degrees leading $\phi$A. The address counters, direction control counter, PROM, D/A converter and inverting/non-inverting amplifier operate in the same manner as those of the basic oscillator. The

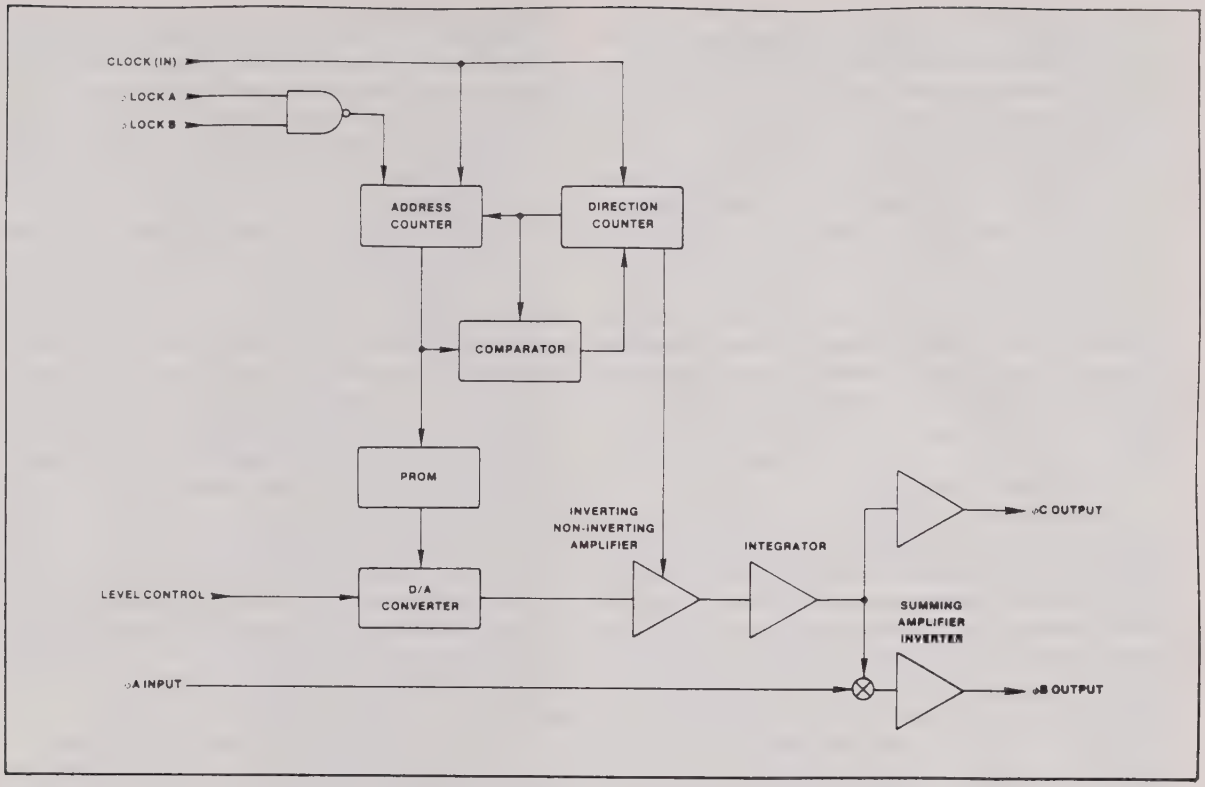



Figure 3-2. Block Diagram, Multi-Phase Generator Board.

output of the ϕC inverting/non-inverting amplifier is combined with the ϕA output in the phase B (ϕB) generator to create the ϕB output.

## 3.3 DETAILED CIRCUIT DESCRIPTION

The paragraphs of this section describe in detail the operation of the circuits of the Model 850T Precision Oscillator. Unless otherwise specified, all text within this section is referenced to the schematic diagrams of Figures 6-4 and 6-7. Where components consist of several discrete circuits within a single package, the individual circuits are identified in the text by the basic component identifier followed by a hyphen and the output pin number. For example, the buffer in U7 that has its output connected to pin 8 is identified as U7-8. If this device is located on circuit board A1, its complete identifier is A1U7-8. However, the prefix is used in the following paragraphs only when necessary to avoid confusion in identifying similarly numbered components located on different boards.

### 3.3.1 PHASE A GENERATOR

#### 3.3.1.1 CRYSTAL OSCILLATOR

Refer to Figure 6-3. Crystal Y1, FET Q3 and associated components comprise an oscillator operating at 10.2 MHz. The oscillator output is bufferd by U7-8 and U7-10 which also convert the oscillator output to a series of TTL compatible pulses.

#### 3.3.1.2 RATE MULTIPLIERS

A complete explanation of the operation of rate multipliers may be found in material published by the device manufacturer. Therefore, the explanation of the rate multiplier circuits herein is limited to that which is peculiar to this design.

A rate multiplier may block pulses appearing at its input from reaching its output or it may pass from one to nine pulses for every ten input pulses, depending on the states of its control inputs. In the 850T Series variable frequency oscillators, the control inputs of the rate multipliers, U1, U2, U3 and U4, are connected to the frequency control switches, S3, S4, S5 and S6. (In the fixed frequency models, they are connected to switches S1 and S2). Rate multiplier U1, for the most significant digit (MSD), is enabled at all times. From 0 to 9 pulses will appear at its output, pin 5, during the time of the first nine of each group of ten oscillator pulses. The actual num-

ber will depend on the setting of the frequency control switch, S6. During the time of the tenth oscillator pulse, its enable output, pin 7, goes low, enabling the next rate multiplier, U3. U3 counts the enable input pulses in the same manner that U1 counted the oscillator pulses. The number that pass to its output will be dependent on the setting of switch S5. However, the output pulse will have the timing and duration of the clock oscillator pulse because it is an input to each rate multiplier. This provides synchronization and uniformity of the pulses at the outputs of the mulitipliers. U4 counts the enabling outputs of U3 and U2 counts those from U4. The output pulses from the rate multipliers are then summed through NAND gate U8-8.

### 3.3.1.3 RANGE SELECTOR

The range selector circuit consists of dual decade counter U11 and selector switch S7. (S7 is installed only in variable frequency models). When S7 is in the X100 position, the pulses at the output of U8-8 pass directly to the address counters, U13 and U18, and to directional control counter U14. When S7 is in the X10 position, the pulses at the output of U8-8 are divided by a factor of ten in one-half of U11. When it is in the X1 position, they are divided by a factor of 100 through both sections of U11.

### 3.3.1.4 ADDRESS AND DIRECTION CONTROL COUNTERS

The address counters, U13 and U18, are so called since they produce the address for the two programmable memories (PROM's) U17 and U19. They are binary counters that are synchronously clocked by the output of U8-8 or by one of the outputs of U11, depending on the position of S7. However, U18 is enabled by the output of U13 only between the rising edges of the 15th and 16th clock pulses and will be clocked by the rising edge of the 16th pulse. Therefore, U13 must be clocked sixteen times for U18 to be clocked once, thirty-two times for it be clocked twice, etc. The four stage outputs of U13 and U18 are connected to the eight inputs of U17 and U19 providing 256 discrete memory addresses.

The array of exclusive NOR gates, U20 and U22, are open-collector types and their combined outputs go high, producing $\phi$LOCK B, when all its inputs are the same, high or low. $\phi$LOCK B occurs when U14-14 (Q0) is high and all stage outputs of U13 and U18 are high, except U13-14 (Q0), at counts 254 and 764. It also occurs when U13-14 is low and all stage outputs of U13 and U18 are low, except U13-14, at counts 509 and 1019. $\phi$LOCK B is an input to the optional multi-phase converter board and to counter U14. U14 is enabled through inverter U7-6 when $\phi$LOCK B goes high and is then clocked once simultaneously with U13 and U18 at clock pulses 255, 510, 765 and 1020. U13 and U18 are advanced one count, since their up/down inputs do not change state until after this clock pulse. The inputs to U20 and U22 are then no longer the same and $\phi$LOCK B goes high, disabling U14. However, U14 was clocked once, changing the state of its $Q_0$ output, pin 14, and the up/down inputs of U13 and U18. The count modes of U13 and U18 are then changed from up to down if pin 14 of U14 goes low or from down to up if it goes high. Thus U13 and U18 are forced to count up from count 001 to count 255, down from count 256 to 510, up from count 511 to 765 and down again from count 766 to 1020.

Counter U14-13 has its $Q_1$ output connected to FET Q7. The purpose of this connection is covered in a later paragraph. Its terminal count output, pin 15, goes low every 4060 counts to provide $\phi$LOCK A which is an input to the optional multi-phase converter board covered in paragraph 3.2.2.

### 3.3.1.5 QUASI-SINUSOID GENERATION

The digital-to-analog converter (D/A converter), U21, and the two amplifiers of U15 generate a quasi-sinsoidal waveform, consisting of 1020 discrete steps, in response to the inputs from programmable memories (PROM's), U17 and U19. The DC input for the D/A converter is provided by the 10 volt regulator, U10, and is adjusted for output level by R29 which is the front panel amplitude control.

The PROM outputs provide the digital input codes for the D/A converter. From the previous paragraphs, it should be apparent that the address for the PROM'S is being repeatedly incremented from 000 to 255 and then decremented from 255 back to 000. Thus, the digital input codes to the D/A converter are, likewise, being incremented and decremented. The PROM's are programmed so that, as their addresses are incremented from 000 to 255, their outputs cause U21 to produce what comprises the first 90 degrees of a quasi-sinusoidal waveform consisting of 255 discrete steps. The amplitude of each step is equivalent to:

$$\sin (90/255 \times A)$$

Where A is the discrete digital address (000 to 255).

As the address is decremented from 255 back to 000, U21 produces the opposite waveform which is the

second 90 degrees (91 to 180 degrees) of a quasi-sinusoidal waveform. The process of address incrementing and decrementing is repetitive. Therefore, in two complete cycles, U21 produces what appears as a sinusoidal waveform after full wave rectification except that it consists of 1020 discrete steps rather than being a pure analog signal. It is only necessary to invert alternate cycles of U21's output to achieve a quasi-sinusoidal waveform. This is accomplished in the amplifiers of U15.

FET Q7 grounds the connection between R27 and pin 3 of U15 whenever its gate is at +5 volts, changing the two sections of U15 from an inverting amplifier to a non-inverting amplifier. In a previous paragraph, it was stated that counter U14 was clocked once at counts 255, 510, 765 and 1020. Its $Q_1$ output, pin 13, therefore, will change state at counts 510 and 1020. Pin 13 of U14 is connected to the gate of FET Q7. Whenever it is low, Q7 is turned off and U15 inverts the output of U21. When it is high, Q7 is turned on and U21's output is not inverted. A complete cycle for U21 occurs between counts 000 and 510 and between 510 and 1020. Thus, alternate cycles will be inverted to form a quasi-sinusoidal waveform at the output of U15. R25 provides a means of equalizing the amplification of U15 in its inverting and non-inverting modes so that the alternate half-cycles of the quasi-sinusoidal waveform are equal in amplitude. The output of U15 is then integrated in U16-1 to provide a ΦA OUTPUT which is a sinusoidal waveform with very low distortion. The signal at pin 3 of U16 is sinusoidal and is passed through U16-7, which has unity gain, to provide the ΦA output of the oscillator.

#### 3.3.1.6 FREQUENCY LIMITER

The purpose of the frequency limiter is to prevent production of an output frequency above or below the range of the AC power source that is driven by the 850T. Its circuit is shown in Figure 6-4 and is comprised of transistors Q1 and Q2, dual timer U6, dual flip flop U5, NAND gate U8-6 and associated components. The $Q_1$ output of counter U14 (pin 14) transitions from high to low once for every half-cycle of the output frequency. This pulse clocks both sections of U5, momentarily turns on Q1 and Q2 to discharge timing capacitors C1 and C2 and triggers both timers of U6. The section of U6 associated with Q2 is adjusted with R6 so that its time period is greater than one half-cycle of the lowest permissible output frequency. As long as the output frequency of the 850T is greater than this low limit, the output of the timer will be high when the next trigger pulse from U14 occurs. The Q output of flip flop U5-5 will not change state and the input of U8-6, connected to it, will remain high. The section of U6 associated with Q1 is adjusted with R1 so that its time period is less than one half-cycle of the highest permissable output frequency. As long as the output frequency of the 850T is less than this high limit, the output of the timer will have transitioned from high to low before the next pulse from U14 occurs. The Q output of U5-8 and the input to U8-5 connected to it will remain high.

While the frequency remains within the set limits, the output of U8-6 will be low (all its inputs are high) and Q6 will be turned off and Q8 will be turned on, completing the path from the +15 volt input to 10 volt regulator U10 which provides the DC input to D/A converter U21. If the selected frequency is below the set limit, pin 2 of U6 will go low before the next pulse. The Q output of U5-5 will be clocked low, the output of U8-6 will go high turning on Q6, turning on the LIMIT LED, CR5, turning off Q8, the DC supply to U10 and the D/A converter. If the selected frequency is higher than the set limit, pin 9 of U6 will be high at the time of the next pulse and the Q output of U5-9 will be clocked low, the output of U8-6 will go high turning on Q6, turning off Q8, the DC supply to U10 and the D/A converter.

A "soft start" feature is incorporated in the frequency limiter circuit that gradually increases the voltage applied to U10 when the unit is first started and whenever it returns to operation after shutting down because of an out-of-limit frequency condition. Q6 will be turned on when power is applied or when an out-of-limit frequency is selected. When it is turned off, R20 and C15 will delay the application of full forward bias to the base of Q8. Thus, the voltage applied to U10 will slowly increase from zero to +15 volts and the output of the D/A converter will, likewise, slowly increase.

#### 3.3.1.7 POWER SUPPLIES

The +15 volt and −15 volt supplies are obtained by regulating the +25 and −25 volt supplies of the associated power source to those levels in the circuits of Q4 and Q5. The +5 volt supply is obtained from 115 volts AC through transformer T1, rectifiers CR3 and CR4 and +5 volt regulator U9.

### 3.3.2 MULTI-PHASE CONVERTER

The multi-phase converter is located on a separate, optional circuit board and the circuits of that board are shown in Figure 6-4. The multi-phase converter generates a phase C (ΦC) output from the ΦA input

which is then combined with the ϕA input to produce the ϕB output. A vector diagram showing the angular displacement of each phase with respect to the others is shown in Figure 3-3. The following paragraphs explain the functioning of the multi-phase converter.

### 3.3.2.1 PHASE C GENERATOR

The phase C generator consists of address counters, a directional control counter system, PROM's, a D/A converter and an inverting/non-inverting amplifier that perform the same functions as those on the ϕA generator board which were decribed in previous paragraphs. The circuits, comprised of counters U1, U2 and U3, exclusive NOR gates U7 and U8, PROM's U4 and U5, D/A converter U9 and operational amplifier U10 are interconnected in the same manner as their counterparts on the ϕA generator board. The counters are clocked by the same signal from A1U8-8 or A1U11. The DC input for the D/A converter is obtained from amplfier A1U12-6 which has its output level adjusted by the front panel amplitude control. Thus the amplitudes of the ϕA and ϕC outputs will be identical. R15 provides a fine adjustment of the ϕC amplitude.

The counters of the multi-phase converter, unlike those of the ϕA generator, are preset at the instant the ϕA output passes through the 180° point on every fourth cycle. The preset causes the waveform generated in this system to be displaced, relative to ϕA such that it lags ϕA by 120 degrees. The preset is accomplished by $\overline{\phi\text{LOCK A}}$ and ϕLOCK B through U6-8 and U6-11. $\overline{\phi\text{LOCK A}}$ goes low one clock pulse prior to the end of every fourth cycle of the output frequency (4078 clock pulses from the output of A1U8-8 or A1U11) and remains low for the next complete cycle. ϕLOCK B, as described in preceding paragraphs, goes high at counts 254, 509, 764 and 1019. Therefore, it goes high at counts 2039, 3059 and 4079. When $\overline{\phi\text{LOCK A}}$ is low and ϕLOCK B goes high, the preset mode of counters U1, U2 and U3 are enabled and preset occurs on the rising edge of the next clock pulse. The counters are preset to the count determined by the connections to their A, B, C and D inputs. S1 is not normally installed and the dotted lines across its sections 2 and 4 represent clad jumpers on the circuit board. As drawn, the A and C inputs of U1 and U2 are grounded (low) and the B and D inputs are at +5 volts. This produces a preset of AA in hexidecimal or 1010 1010 in binary. This presets the PROM address at 170. The directional control counter, U3, is preset so that its $Q_A$ output is low and its $Q_B$ output is high. Thus, counters U1 and U2 will be in the count down mode and U10 will be in its inverting mode. The amplitude of the waveform developed at the output of U9 from this point forward will be decreasing from maximum and, since U10 is in an inverting mode, the output of U10 will be 120° leading ϕA which is the correct phase angle for ϕC. The signal output of U10 is buffered by U12-7 to provide ϕC OUTPUT at pin 14 of J1. Capacitor C8 provides high frequency roll-off for U12-7.

### 3.3.2.2 B PHASE GENERATOR

The ϕB signal is obtained by summing ϕA and ϕC signals of equal amplitudes and then inverting the resultant signal through an operational amplifier. The ϕA OUTPUT signal input to this board is obtained from amplifier A1U16 which isolates it from the ϕA OUTPUT signal to the power source which is obtained at the output of A1U16-7. The ϕC signal is obtained from the output of amplifier U12-1. The two signals are summed at the input of amplifier U11-1 through the resistor network of R11 and the two sections of R3. R11 provides a fine adjustment of the ϕB angle and R7 provides a fine adjustment of the ϕB amplitude. The ϕB is buffered in U11-7 to produce ϕB OUTPUT at pin 13 of J1.

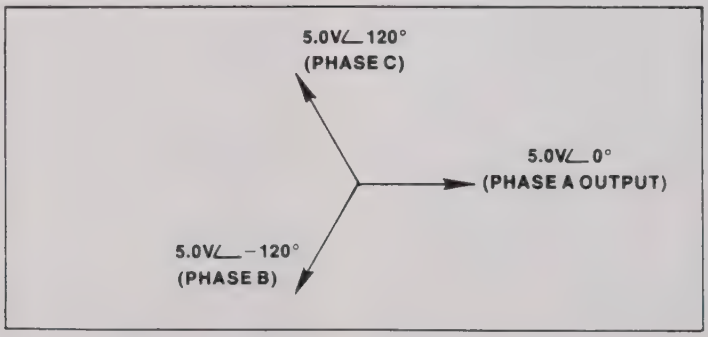



Figure 3-3. Three Phase Vector Diagram.

# SECTION IV
# ADJUSTMENT PROCEDURES

## 4.1 GENERAL

The following adjustment procedure, or any part of it, may be performed on a routine basis to insure that the oscillator remains within the specified performance limits. The procedure should always be performed after service to the oscillator.

The procedure outlines calibration of the main board (A1) which controls output frequency and phase A ($\phi$A) distortion, and of the Phase Board (A2) which controls the phase B ($\phi$B) and phase C ($\phi$C) amplitude and distortion.

Calibration of either the 850T or 855T Series Oscillators requires a test fixture or compatible power sources as shown in Figure 4-1. An extender accessory, Part No. 4800-703, may be used if the oscillator is to be calibrated while connected to an Invertron® power source.

## 4.2 PROCEDURE

### 4.2.1 SINGLE PHASE MODELS

#### 4.2.1.1 DISTORTION

Connect a distortion analyzer between pin 2 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the output of the power source may be monitored with the distortion analyzer. Adjust the front panel AMPLITUDE control to produce 5 volts RMS at the output of the oscillator, pin 2 of J2, or for full scale output of the power source. Adjust potentiometer A1R25, on the main board, for indication of lowest distortion content.

Reduce the front panel AMPLITUDE control to produce 1 volt RMS at the oscillator phase A output. Adjust A1R24 for the lowest distortion level.

**CAUTION**

Voltages up to 500 Volts AC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

**DEATH**

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug-in oscillator, the primary power circuits and output circuits of the associated Invertron® if oscillator is tested and/or adjusted with Invertron®.

### 4.2.2 TWO-PHASE MODELS

The distortion adjustment must be made prior to the

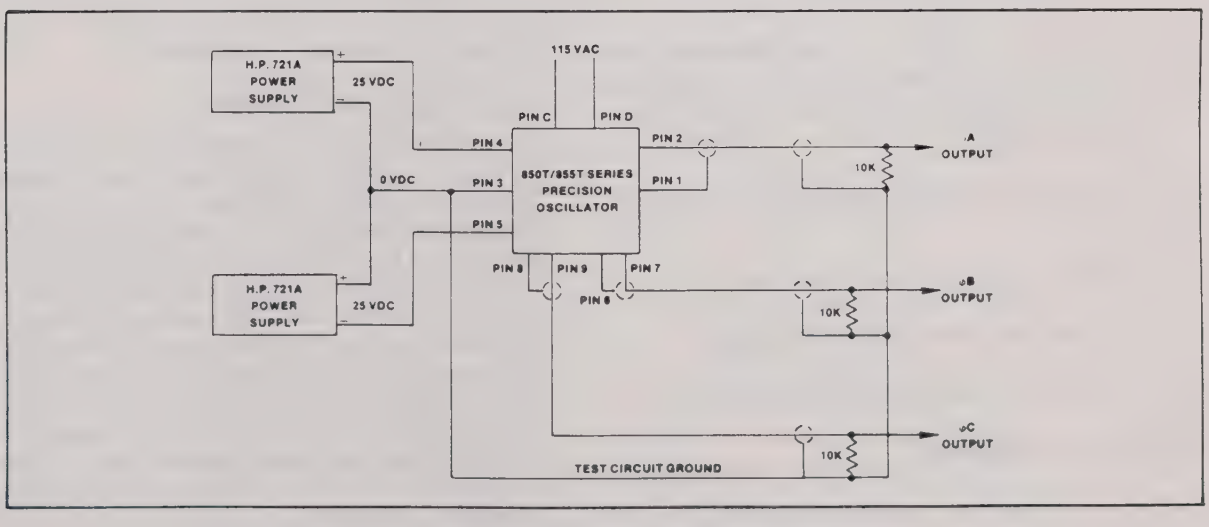



Figure 4-1. Test Circuit for 850T/855T Series Oscillators.

LEVEL adjustment of 4.2.2.2 because of interaction of the adjustments.

#### 4.2.2.1 DISTORTION

A. Connect a distortion analyzer between pin 2 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the ϕA output of the power source may be monitored with the distortion analyzer. Adjust the front panel AMPLITUDE control to produce 5 volts RMS at the output of the oscillator, pin 2 of J2, or for full scale output of the power source. Adjust potentiometer A1R25, on the main board, for indication of lowest distortion content.

B. Connect the distortion analyzer between pin 9 and pin 8 (ground) of connector J2. If the oscillator is connected to the power source, the ϕC output of the power source may be monitored with the distortion analyzer. Adjust potentiometer A2R14, on the phase board for an indication of lowest distortion content in the ϕC output.

Reduce the front panel AMPLITUDE control to produce 1 volt RMS at the oscillator phase C output. Adjust A2R13 for the lowest distortion level.

#### 4.2.2.2 AMPLITUDE ADJUSTMENT

Connect an AC digital multimeter between pins 2 an 8 of J2 ( A). Adjust the front panel amplitude control for 5.00 volts RMS. Connect the AC digital multimeter between pin 9 and pin 8 of J2. Adjust A2R15 for 5.00 ± 0.05 volts.

### 4.2.3 THREE-PHASE MODELS

There is some interaction in the following adjustments. For the correct alignment of the three-phase oscillators, the following adjustments must be made in the order shown:

A. Adjust the ϕA and ϕC distortion as directed in 4.2.2.1.

B. Adjust the level of ϕC relative to ϕA.

C. Adjust the phase angle of the ϕB output.

D. Adjust the amplitude of ϕB relative to ϕA.

#### 4.2.3.1 DISTORTION

Perform the tests outlined in paragraphs 4.2.2.1 and 4.2.2.2.

#### 4.2.3.2 PHASE ADJUSTMENT

A. Connect the differential phase meter between pins 2 ( A), 7 ( B) and ground. Adjust the frequency of variable frequency models (850T) to 100 Hz, or less. Adjust potentiometer A2R11 on the Phase Board (A2) for a phase meter indication of A leading B by 120 degrees.

#### 4.2.3.3 AMPLITUDE ADJUSTMENT

A. Monitor the ϕA output of the oscillator with an AC digital multimeter connected between pins 2 and 8 (ground) of connector J2. Adjust the front panel AMPLITUDE control for a 5.0 volts RMS reading.

B. Connect the digital multimeter to pin 7 of connector J2. Adjust potentiometer A2R7 on the Phase Board for a 5.0 volts RMS reading.

### 4.2.4 FREQUENCY LIMIT ADJUSTMENT

The frequency limiter prevents the 850T/855T Series Oscillators from driving the associated power source with a frequency that is outside the power source operating limits. If the dials of the 850T are set at a frequency outside those limits, or if the frequency determining circuits should malfunction, the output of the oscillator will be shut off and a red LIMIT indicator on the front panel will light. The LIMIT indicator will be extinguished and the output will be turned back on when the dials are set to a frequency within the power source limits. The limiter is also a feature of the 855T and safeguards against a malfunction of the frequency determining circuits. The standard adjustment permits oscillator operation between the limits of 45 Hz and 5000 Hz. If a wide-band power source is to be driven by either oscillator, the limits may be readjusted.

#### 4.2.4.1 850T ADJUSTMENT

To adjust the upper frequency limit, set the RANGE switch to X100 and select the highest frequency desired. Adjust potentiometer A1R1 on the main board (A1) to the point where the LIMIT indicator is illuminated then back off on the adjustment slightly. Select a frequency higher than the set limit and verify LIMIT indicator illumination. Similarly, set the lower limit frequency and adjust A1R6 for LIMIT indicator illumination then back off on that adjustment slightly. Select a frequency lower than the set limit and verify LIMIT indicator illumination. When adjusting the limit potentiometers, note that some hysteresis exists in the adjustments. This prevents amplitude chatter when programming frequencies around the frequency limits.

### 4.2.4.2 855T ADJUSTMENT

The adjustment for the 855T is accomplished in the same manner as that for the 850T described in 4.2.4.1 except that the upper and lower limits must be set with the DIP switches mounted on the main board (A1). Figure 4-2 shows the location of the DIP switches. Table 4-1 lists the switch closures necessary to program 45, 60, 400 and 5000 Hz. If it is desired to program other frequencies, contact California Instruments' Customer Service Department for assistance.

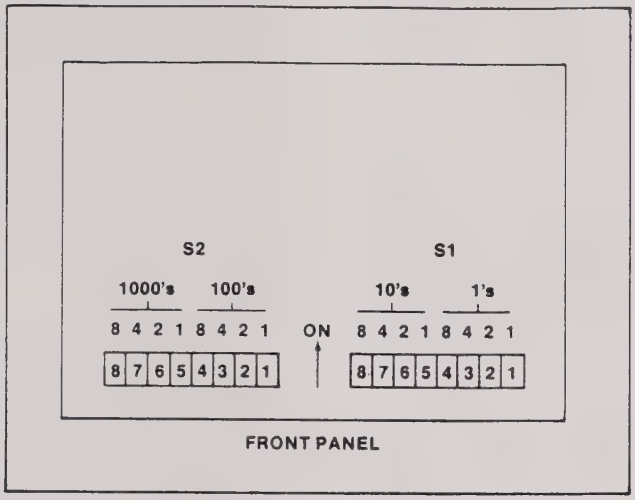



Figure 4-2. Location of Frequency Programming DIP Switches, Model 855T.

Table 4-1. Model 855T Frequency Programming.

| | S2 | | S1 | |
|---|---|---|---|---|
| | 8 7 6 5 | 4 3 2 1 | 8 7 6 5 | 4 3 2 1 |
| 45 Hz | X X X X | X X X X | X - X X | X - X - |
| 60 Hz | X X X X | X X X X | X - - X | X X X X |
| 400 Hz | X X X X | X - X X | X X X X | X X X X |
| 5000 Hz | X - X - | X X X X | X X X X | X X X X |

- = OFF
X = ON

# SECTION V—MAINTENANCE

## 5.1 GENERAL

This section of the manual contains information to assist in troubleshooting the Models 850T and 855T Precision Oscillators. A table of power supply voltages and "logic tree" types of troubleshooting charts are included. A review of the Theory of Operation in Section III is recommended prior to attempting to troubleshoot either unit. The technician will then have a good understanding of the circuit operation which will further assist in the troubleshooting task.

## 5.2 REQUIRED TEST EQUIPMENT

The test equipment required to perform the tests outlined in this section is listed in Table 5-1.

Table 5-1. Required Test Equipment.

| |
|---|
| California Instruments Model DMM-53 Digital Multimeter. |
| Frequency Counter with 20 MHz capability. |
| Calibrated Oscilloscope with 20 MHz, or better, response. |

### 5.3.1 POWER SUPPLY TEST

Reduce the output of the oscillator to zero and measure the +15 volt, −15 volt and +5 volt supply lines. Verify that they are within the limits shown in Table 5-2.

If the power supply voltages are within limits, proceed to the next paragraph. If they are not, troubleshoot and repair the defective power supply.

### 5.3.2 CLOCK GENERATOR TEST

Check the clock generator signal with the oscilloscope at A1U13, pin 2. The clock signal should be a square wave with an amplitude of 3 volts, or more, peak-to-peak. If there is no clock signal, refer to the clock generator troubleshooting chart of Figure 5-1. If the clock signal is present, but the oscillator output is absent or severely distorted, refer to the waveform synthesizer troubleshooting chart of Figure 5-2.

Table 5-2. Power Supply Voltage Limits.

| LINE | TEST POINT | LIMITS |
|---|---|---|
| +15V | TP3 | +14.6 to +16.2 VDC |
| −15V | TP2 | −14.6 to −16.2 VDC |
| +5V | | +4.75 to +5.25 VDC |

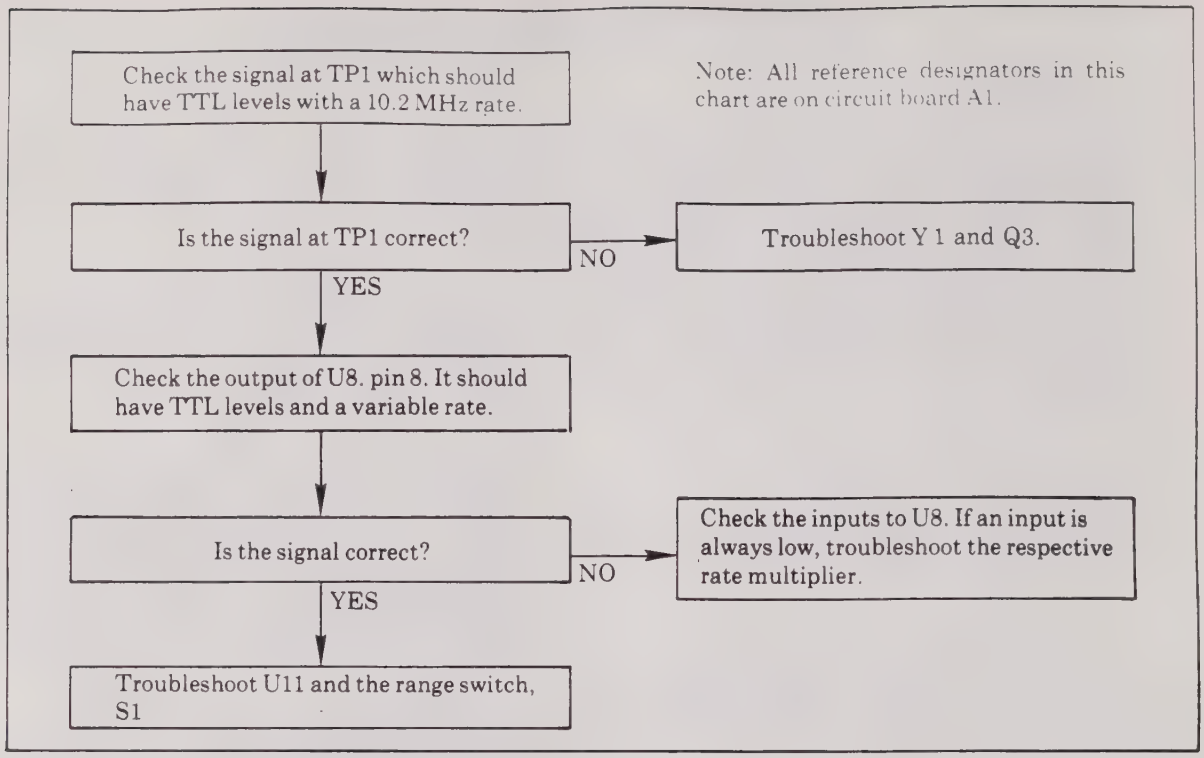

Check the signal at TP1 which should have TTL levels with a 10.2 MHz rate.
Note: All reference designators in this chart are on circuit board A1.
Is the signal at TP1 correct?
NO
Troubleshoot Y 1 and Q3.
YES
Check the output of U8. pin 8. It should have TTL levels and a variable rate.
Is the signal correct?
NO
Check the inputs to U8. If an input is always low, troubleshoot the respective rate multiplier.
YES
Troubleshoot U11 and the range switch, S1

Figure 5-1. Troubleshooting Chart, Clock Generator.

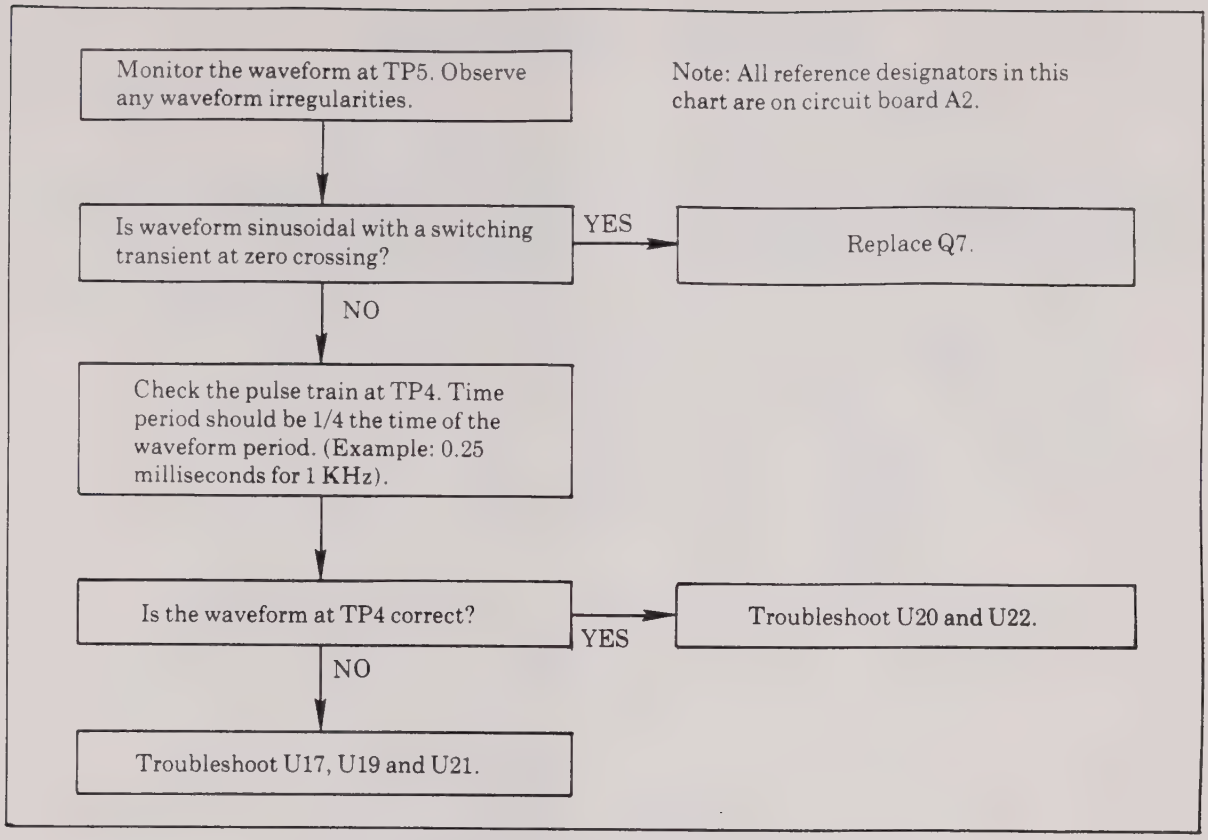

Monitor the waveform at TP5. Observe any waveform irregularities.
Note: All reference designators in this chart are on circuit board A2.
Is waveform sinusoidal with a switching transient at zero crossing?
YES
Replace Q7.
NO
Check the pulse train at TP4. Time period should be 1/4 the time of the waveform period. (Example: 0.25 milliseconds for 1 KHz).
Is the waveform at TP4 correct?
YES
Troubleshoot U20 and U22.
NO
Troubleshoot U17, U19 and U21.

Figure 5-2. Troubleshooting Chart, Waveform Synthesizer.

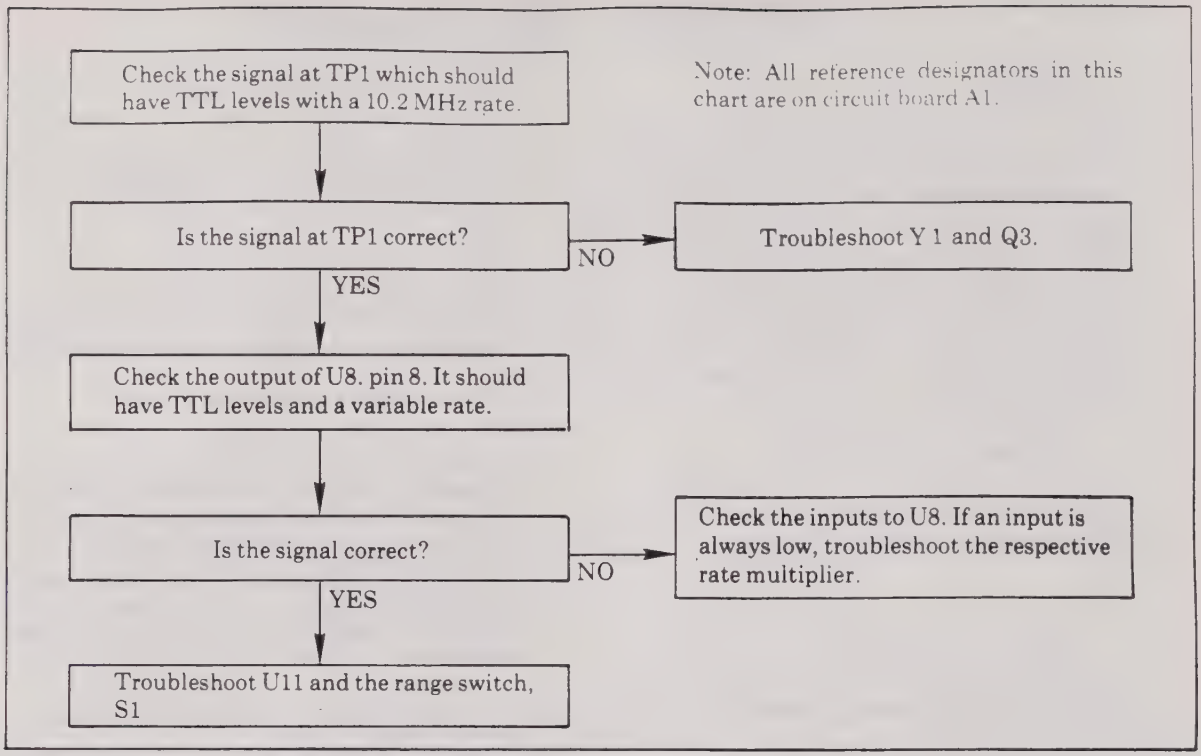

Check the signal at TP1 which should have TTL levels with a 10.2 MHz rate.
Note: All reference designators in this chart are on circuit board A1.
Is the signal at TP1 correct?
NO
Troubleshoot Y 1 and Q3.
YES
Check the output of U8. pin 8. It should have TTL levels and a variable rate.
Is the signal correct?
NO
Check the inputs to U8. If an input is always low, troubleshoot the respective rate multiplier.
YES
Troubleshoot U11 and the range switch, S1

Figure 5-1. Troubleshooting Chart, Clock Generator.

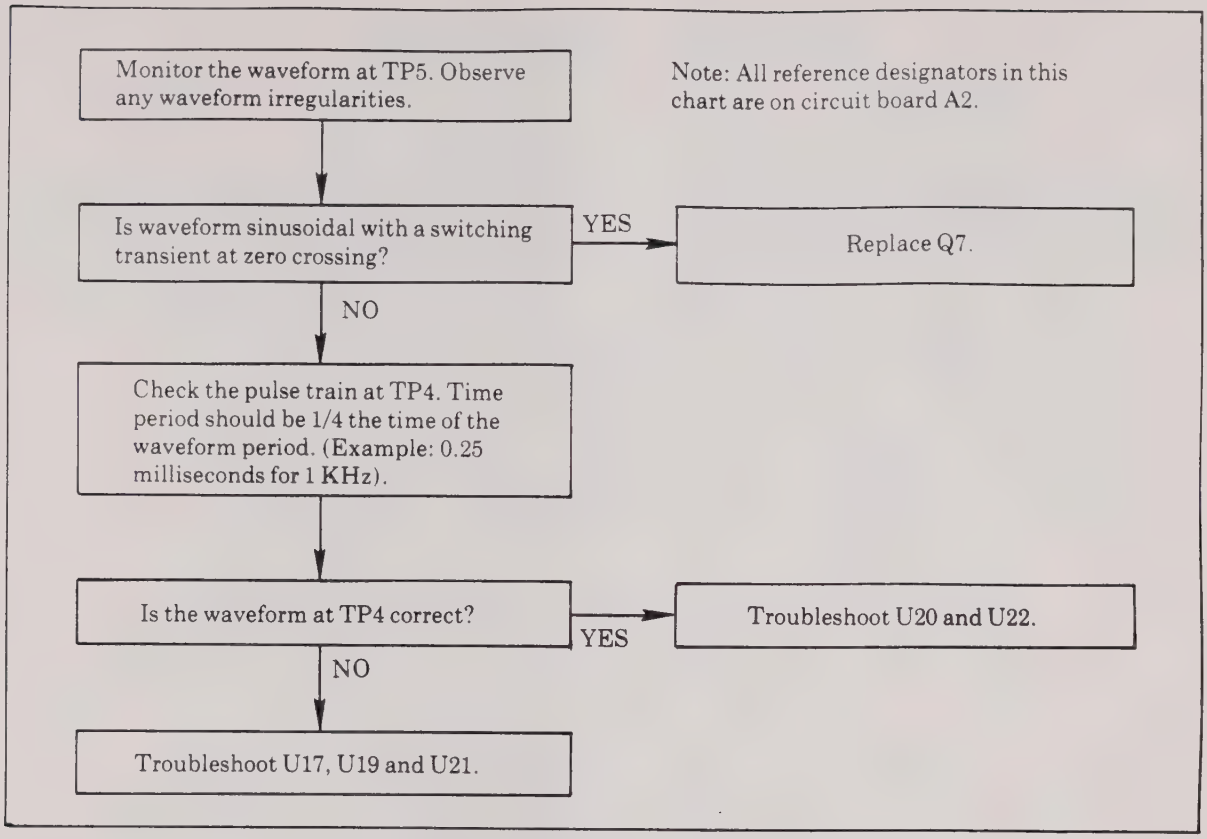

Monitor the waveform at TP5. Observe any waveform irregularities.
Note: All reference designators in this chart are on circuit board A2.
Is waveform sinusoidal with a switching transient at zero crossing?
YES
Replace Q7.
NO
Check the pulse train at TP4. Time period should be 1/4 the time of the waveform period. (Example: 0.25 milliseconds for 1 KHz).
Is the waveform at TP4 correct?
YES
Troubleshoot U20 and U22.
NO
Troubleshoot U17, U19 and U21.

Figure 5-2. Troubleshooting Chart, Waveform Synthesizer.

# SECTION VI—DIAGRAMS

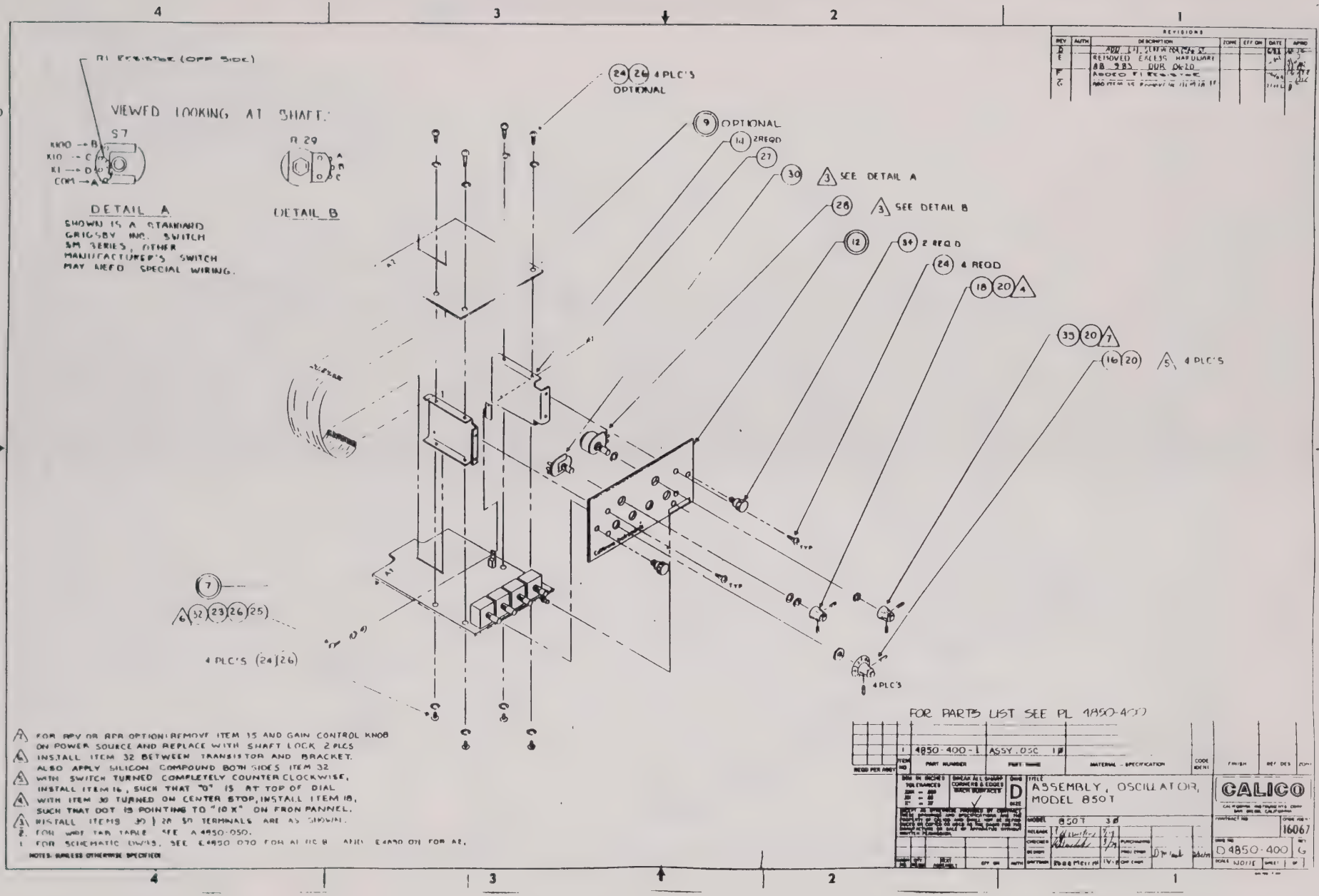
## 6.1 GENERAL

This section of the manual contains schematic and mechanical diagrams necessary for the operation and maintenance of the 850T/855T Series Precision Oscillators. The schematic diagrams illustrate the circuits while the mechanical assembly drawings indicate the component locations.

## 6-3 REFERENCE DESIGNATIONS

6-4 Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or subassembly designation for the complete reference designator. For example:

| Assembly/Sub-Assembly | Component | Component Designation |
|---|---|---|
| None | T1 | T1 |
| A1 | IC6 | A1IC6 |
| A2 | R44 | A2R44 |
| A3 | C7 | A3C7 |
| A4 | Q2 | A4Q2 |




REVISIONS

| REV | AUTH | DESCRIPTION | ZONE | EFF ON | DATE | APPRD |
|---|---|---|---|---|---|---|
| D | | ADD [illegible] | | | 6/11 | |
| E | | REMOVED EXCESS HARDWARE | | | | |
| F | | AB 383 DWR D620 | | | | |
| G | | ADDED R1 RESISTOR | | | | |

⚠ FOR RPV OR RPR OPTION: REMOVE ITEM 15 AND GAIN CONTROL KNOB ON POWER SOURCE AND REPLACE WITH SHAFT LOCK 2 PLCS
⚠ INSTALL ITEM 32 BETWEEN TRANSISTOR AND BRACKET. ALSO APPLY SILICON COMPOUND BOTH SIDES ITEM 32
⚠ WITH SWITCH TURNED COMPLETELY COUNTER CLOCKWISE, INSTALL ITEM 16, SUCH THAT "0" IS AT TOP OF DIAL
⚠ WITH ITEM 30 TURNED ON CENTER STOP, INSTALL ITEM 18, SUCH THAT DOT IS POINTING TO "10 X" ON FRON PANNEL.
⚠ INSTALL ITEMS 30 & 28 SO TERMINALS ARE AS SHOWN.
2. FOR WIRE TAB TABLE SEE A 4850-050.
1. FOR SCHEMATIC DWGS. SEE E4850 070 FOR A1 SIZE B AND E4850 071 FOR A2.

NOTES: UNLESS OTHERWISE SPECIFIED

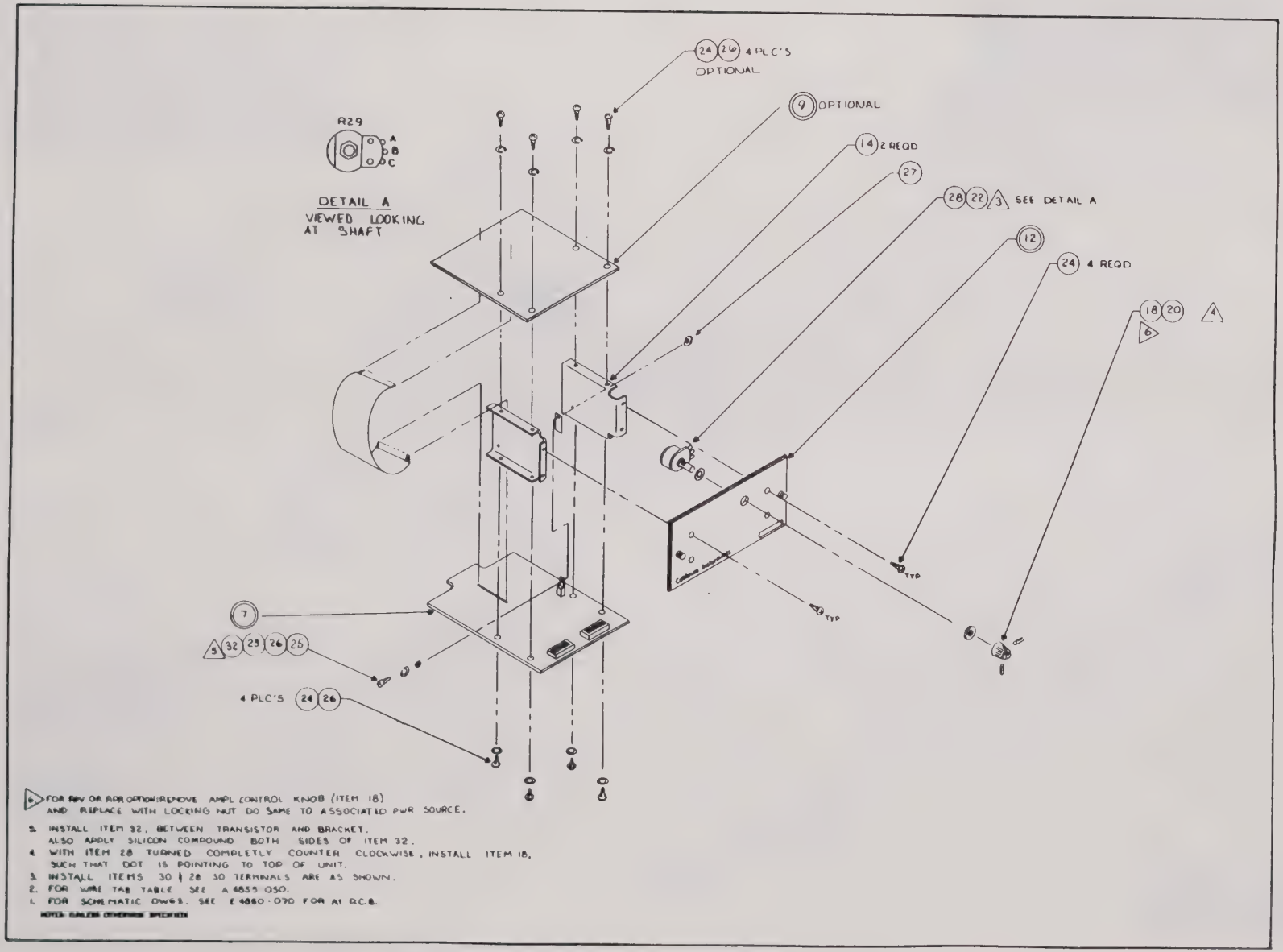
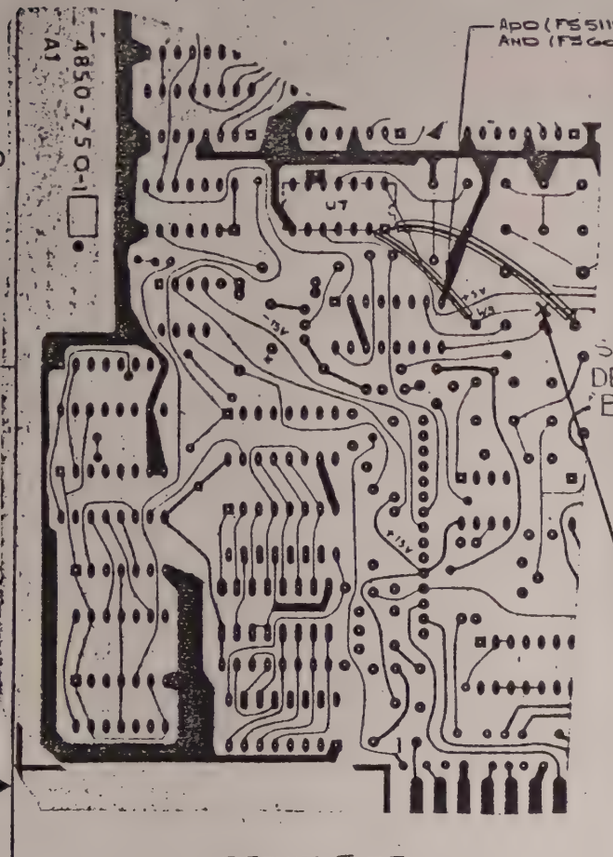
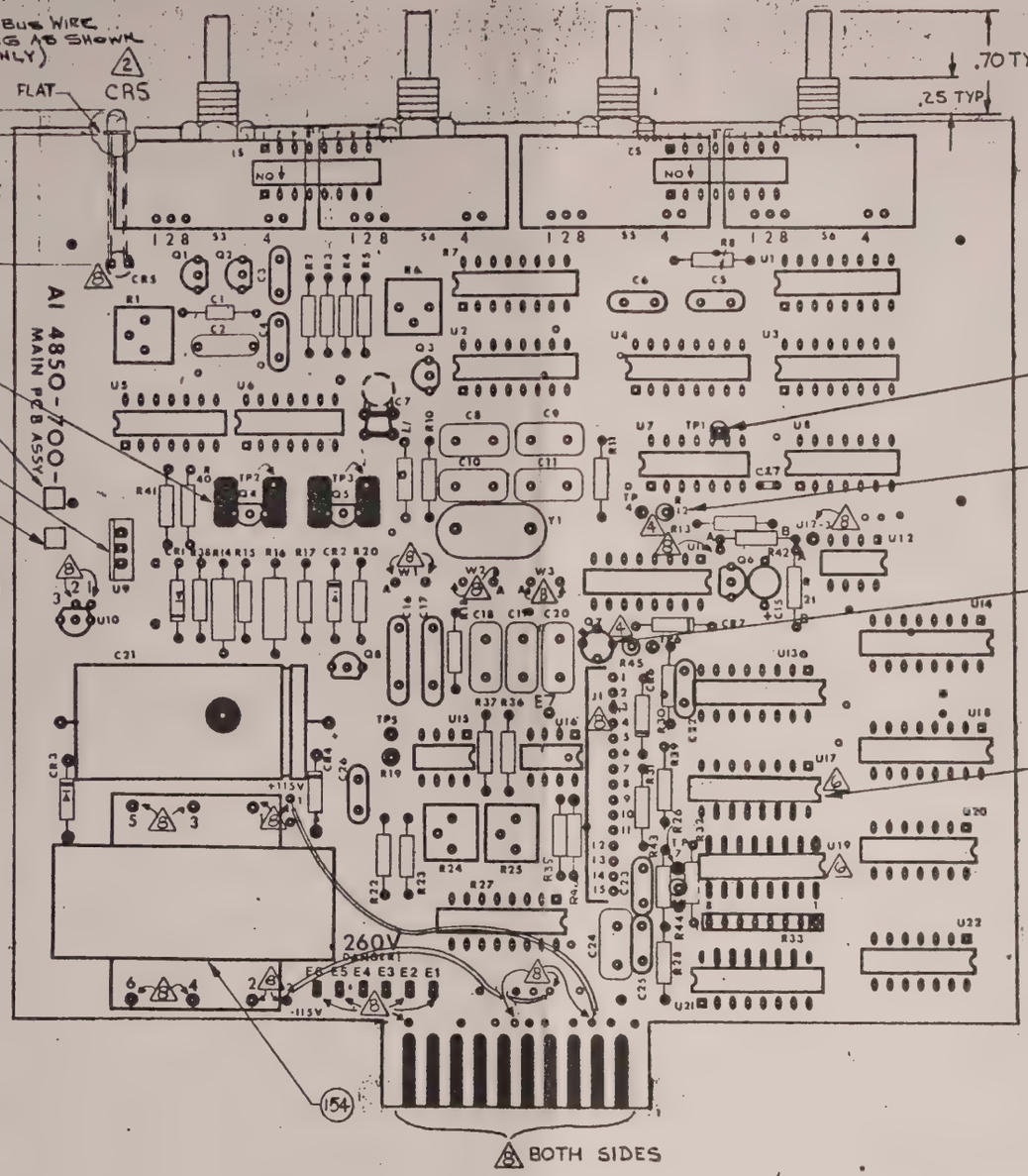

24 26 4 PLC'S OPTIONAL
9 OPTIONAL
14 2 REQD
27
28 22 3 SEE DETAIL A
12
24 4 REQD
18 20 4
6
R29
A
B
C
DETAIL A
VIEWED LOOKING AT SHAFT
7
5 32 23 24 25
4 PLC'S 24 26
TYP
TYP
6 FOR RRV OR RRR OPTION: REMOVE AMPL CONTROL KNOB (ITEM 18) AND REPLACE WITH LOCKING NUT DO SAME TO ASSOCIATED PWR SOURCE.
5. INSTALL ITEM 32, BETWEEN TRANSISTOR AND BRACKET. ALSO APPLY SILICON COMPOUND BOTH SIDES OF ITEM 32.
4. WITH ITEM 28 TURNED COMPLETLY COUNTER CLOCKWISE, INSTALL ITEM 18, SUCH THAT DOT IS POINTING TO TOP OF UNIT.
3. INSTALL ITEMS 30 & 28 SO TERMINALS ARE AS SHOWN.
2. FOR WIRE TAB TABLE SEE A 4855 050.
1. FOR SCHEMATIC DWGS. SEE E 4860-070 FOR A1 P.C.B.

Figure 6-2. Assembly Diagram, Model 855T Oscillator.

| REV | AUTH | DESCRIPTION | ZONE | EFF ON | DATE | APRO |
|---|---|---|---|---|---|---|
| M | | ECO 1107 BS 5-5-82 | | | 9/1/82 | |
| N | | ECO 1107 BS 5-5-82 | | | | |
| P | | NOTE BY BUBBLE NO. 115 WAS TP1, TP2, TP6 DDR 0503 AB 12/82 | | | | |
| R | | ADD CO BUS WIRE & TUBING | | | | |
| S | | CHANGE ROUTE OF BUSWIRES | | | | |
| T | | ADD C27. | | | | |




(115) SEE DETAIL C
TP1, TP2, TP3

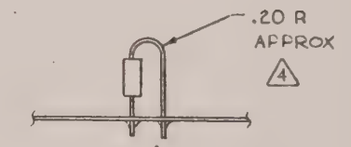
4 SEE DETAIL A
R12, R19, R26, R44, R45

(152) INSTALL UNDER Q7

(150) INSTALL UNDER U17/U19

DETAIL C
TP1, TP2, TP3

DETAIL B
Q4, Q5




DETAIL A
R12, R19, R26, R44, R45

15 PERMANENTLY MARK LATEST ASSY REV LTR IN SPACE PROVIDED.

14. FOR OPTION RPV: SEE E.R.A., ASSEMBLY DRAWING D4850-400. ADD 24 AWG RED JUMPER FROM A1U10-1 TO A1E5. ADD 24 AWG BLACK JUMPER FROM A1J2-10 TO A1R29-A. SEE W.T.T.
13. FOR OPTION "A": THIS CREATES AN .0001% ACCURACY ON A1 P.C.B. ADD A1C7 (CALICO #6-10909), DELETE A1C10 (CALICO #6-10003), REPLACE WITH A1C10 CALICO #6-11072. SEE E.R.A. AND TEST PROCEDURE.
12. FOR OPTIONAL 260V SERVO OUTPUTS: A2 P.C.B. (4850-702-2 OR 4850-702-3) IS USED. SEE SCHEMATIC 4850-078. SEE ALSO E.R.A. TO CONVERT OUTPUT, SEE W.T.T.
11. FOR SQUARE WAVE OPTION: OSCILLATOR CAPABILITY EXTENDS ONLY TO 1Ø AND 2Ø AND 3D PHASE UNITS. SEE 4850-410 2 ADD/DEL PARTS LIST FOR MODS. TO 4850-700 (A1) P.C.B. AND 4850-702 (A2) P.C.B.

10. FOR RESISTANCE PROGRAMMING: IF 2Ø OR 3Ø OUTPUTS ARE NEEDED, USE A2 P.C.B. (4850-702-1). SEE SCHEMATIC E4850-078 FOR CHANGES TO A2 P.C.B. ALSO SEE 4850-410-1 ADD/DEL PARTS LIST FOR CHANGES TO A1 P.C.B AND A2 P.C.B. SEE W.T.T.

9 SOLDER U9 IN PLACE, AFTER SIDE BRACKET IS IN PLACE.
8 CLAD PADS MUST BE MASKED BEFORE WAVE SOLDER.
7 WHEN ASSEMBLING PC.B. MARK DASH NUMBER (-1, -2, -3, ETC.) IN BLOCK PROVIDED.
6 I.C.'s U17 AND U19 MUST BE PROGRAMMED PER SPEC CIC 207-3 FOR U17 AND CIC 207-2 FOR U19.
5. WIRE TAB TABLE (W.T.T.) IS 4850-050 FOR 850T AND 4855-050 FOR 855T/853T.
4 INSTALL ITEMS R12, R19, R26 AS SHOWN IN DETAIL "A".
3. NOTE THAT THIS ASSEMBLY SHOWS LOCATIONS FOR ALL POSSIBLE COMPONENTS. SEE PARTS LIST FOR COMPONENTS NOT USED IN SPECIFIC ASSEMBLIES.
2 INSTALL CR5, AS SHOWN, AFTER WAVE SOLDER.
1. FOR SCHEMATIC, SEE DRAWING E4850-070.

NOTES: (UNLESS OTHERWISE SPECIFIED)

| | | | |
|---|---|---|---|
| | RPV | SEE ERA | NOTE 14 |
| | "A" | .0001% ACCURACY | NOTE 13 |
| 4850-410-2 | | SQUARE WAVE | NOTE 11 |
| 4850-410-1 | RPR | RESISTANCE PROGR. | NOTE 10 |
| 4850-700-3 | | STD 853T SEE ERA | |
| 4850-700-2 | | STD 855T SEE P.L. | |
| 4850-700-1 | | STD 850T SEE P.L. | |
| ASSEMBLY NO. | OPTION | FUNCTION / NOTE REF | |

SEE SPECIFIC PARTS LIST OR ERA FOR EACH OPTION

OPTION LIST FOR 850T/853T/855T

FOR PARTS LIST SEE PL 4850-700-1, -2, -3

| REQD PER ASSY | ITEM NO. | PART NUMBER | PART NAME | MATERIAL — SPECIFICATION | CODE IDENT | FINISH | REF DES. | ZONE |
|---|---|---|---|---|---|---|---|---|

DIM IN INCHES TOLERANCES .XXX = .010, .XX = .03, X° = 30' — BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √ — DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: PRINTED CIRCUIT ASSY MAIN BOARD A1

MODEL 850T

| | | | | | |
|---|---|---|---|---|---|
| RELEASE | Richard | 10/12 | PURCHASING | | |
| CHECKER | W Diebold | 10/12 | | | |
| DESIGN | | | PROJ ENGR | D.M. Fowler | 10/26/82 |
| DRFTSMN | Robb | 9/7/82 | CHF ENGR | | |

CALICO — CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO. — CODE IDENT 16067

DWG NO. 4850-700 — REV T

SCALE 2/1 — SHEET — OF

| DASH NO. | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH |
|---|---|---|---|---|
| -3 | 1 | 4853-400 | 853T | |
| -2 | 1 | 4855-400 | 855T | |
| -1 | 1 | 4850-400 | 850T | |

4 3 2 1

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| REV | AUTH | DESCRIPTION | ZONE | EFF ON | DATE |
| A | | | | | |
| B | | | | | |
| C | | ALIVE! | | | |
| D | | | | | |
| E | | 990 | | | |
| F | | ECO 1019 | | | |
| G | | ECO 1089 | | | |
| H | | | | | |
| J | | CHANGE CAP TUNE 0439 | | | |
| K | | ECO #18 (A8 ONLY) A1 PWB MOD | | | |
| L | | ADD ANCL SPEC | | | |
| M | | ECO 1157 AB 12-83 | | | |
| N | | DELETE R46 R47 R48 R49 R50 R51 ONLY | | | |
| P | | ADD C27, DISC W3 FROM U12 | | | |

FRONT PANEL FREQUENCY SWITCH

MSD S6 S3 S4 S9 LSD

S7 FRONT PANEL RANGE SWITCH

R1/4.7K 4850-7000-1 & -3 ONLY

10.2 MHz ±.005%

SN74LS04N OR 74ALS04 4850-7000-1 ONLY

SN74167N U1 U3 U4 U2

SN74LS20 U8

SN74LS30 U11

NOT CONNECTED ON 4850-7000-1

W1 W2 W3

C27 0.1

C7 6.5pf

Y1 10.2MHz

L1 2.2µH

C10 100pf 500V

C9 10pf

C11 .01µf 500V NOM. TBD

C8 .33µf 500V

R10 100Ω

R11 4.7K

Q3 2N5246

CLOCK

Ø LOCK A

Ø LOCK B

Ø A OUTPUT TO TOP BOARD

TO J2 PIN ③

U13 U18 U14 U7 U17 U19 U21 NE5009N

C22 .01,50

C24 .01

C23 .01,50

C25 .05/50

R12 1K

R45 1M

Q7 SD213

C18 .1/250

R36 10

R35 33K

U16 LM4562N

R37 10

R34 10

R19 8.66K 1%

R18 33.2K

C19 250

C17 .1/250

C20 820

R27 6.8K

R23 500

R21 6.8K

R22 100

R24 100

C16

U15 TL072CP

R26 4.53K

R44 4.53K

R43 4.32K

R28 4.7K

R38 10

R39 10

R31

R21 10K

R42 B

LM741EN

AMPLITUDE ADJUST R29 LOCATED ON FRONT PANEL

10K

TO J2-10

TO J2 L

R4 4.7M

R5 47K

R6 100K

R2 4.7M

R3 10K

R1 100K

R3 39K

C2 .1

C4 .01/50

C3 .01/50

C1 1000

U5 U6 U8

2N2907A Q1

2N2222A Q2

C15 4.7µf

CR6

Q6 Q8

R20 100K

R30 220

CR5 LSL-3L

U10

R16 47Ω 1W

R17 1K

Q5 PE8050

CR2 1N5246B

R14 68Ω 1W

R15 1K

Q4 PE8550

CR1 1N5246B

PAD

TP5 +14.6 to +16.2

TP2 -14.6 to -16.2

TP4 TP6

+15 -15

ØA OUTPUT

ØB OUTPUT

ØC OUTPUT

ØD OUTPUT

TO U16 PIN 7

J1-11 J1-8 J1-13 J1-14 J1-9

J1-1 A J1-3 A J1-2 D

115 VAC

T1 PC20-500

CR4 CR3 1N4004

C21 3300/16V

U9 LM340-5T

J2

E1 → TO A2 J2-1 130V AØ

E3 → TO A2 J3-1 130V BØ

E5 → TO A2 J4-1 130V CØ

HI SERVO OUTPUT

E2 → TO A2 J2-3 130V AØ

E4 → TO A2 J3-3 130V BØ

E6 → TO A2 J4-3 130V CØ

LO SERVO OUTPUT

J1-1 J1-5 J1-7 J1-10 J1-6 J1-12 J1-15

10. For Resistance Programming: If 2Ø or 3Ø outputs are needed, use A2 P.C.B. (4850-702-1). See Schematic E4850-078 for changes to A2 P.C.B. Also see 4850-410-1 add/delete parts list for changes to A1 P.C.B. and A2 P.C.B. See W.T.T.
9. For Servo Outputs: Standard output is 130V. A2 P.C.B. (4850-702) must be used. Connections to A1E1 through A1E6 must be made. See W.T.T. and Schematic 4850-078.
8. W1 jumper is installed in 855T only. W2 and W3 jumpers are not used on standard 850T or 855T.
7. S3, S4, S5, S6 and S7 are used on 850T only. S1 and S2 used on 855T.
6. All wave forms shown with frequency programmed to 1KHz and maximum amplitude.
5. ③ indicates card edge connector.
4. Note that this Schematic is a reference drawing; for specific parts used refer to Parts List of specific model.
3. For W.T.T. see 4850-050 for 850T and 4855-055 for 855T/853T.
2. All resistors are in OHMS, kW, 5%.
1. All capacitors are in Microfarads/Voltage.

NOTES: (Unless otherwise specified).

16. Listed here are last components used: J2, C26, C27, D8, D96, S7, T1, TP6, Ø22 and Y1.
15. Listed here are components used only in special applications: R36, R37, D41.
14. For Option RPV: See E.R.A., Assembly drawing D4850-400. Add 24 AWG red jumper from A1J10-1 to A1E5. Add 24 AWG black jumper from A1J2-10 to A1R29-A. See W.T.T.
13. ~~For Option "A": This changes on 00012 assembly on A1 P.C.B. Add A1C7 (Calico #5-10008). Delete A1C10 (Calico #5-10003). Replace with A1C10 (Calico #5-11073). See E.R.A. and Test Procedure.~~
12. For Optional 260V Servo Outputs: A2 P.C.B. (4850-702-2 or 4850-702-3) is used. See Schematic 4850-078, see also E.R.A. To convert output, see W.T.T. 4850-050 for 850T or 4855-050 for 855T/853T.
11. For Square Wave Option: Oscillator capability extends only to 1Ø and 2Ø and 3Ø units. See 4850-410-2 add/delete for mods to A1 and A2 P.C.B.

| | | | |
|---|---|---|---|
| | RPV | VOLTAGE PROG. SEE ERA | NOTE 14 |
| | A | .0001% ACCURACY | NOTE 13 |
| | | SQUARE WAVE | NOTE 11 |
| | RPR | RESISTANCE PROG | NOTE 10 |
| 4850-700-3 | | STD 853T SEE ERA | |
| 4850-700-2 | | STD 855T | NOTES 7,8 |
| 4850-700-1 | | STD 850T | NOTES 7,8 |
| ASSY NO. | OPTION | FUNCTION / NOTE REF | |

SEE SPECIFIC PARTS LIST OR ERA FOR EACH OPTION

OPTION LIST FOR 850T/853T/855T

| ITEM NO | PART NUMBER | PART NAME | MATERIAL — SPECIFICATION | CODE IDENT | FINISH | REF DES. |
|---|---|---|---|---|---|---|
| NEED PER ASSY | | | | | | |

DIM IN INCHES TOLERANCES .XXX ± .010 .XX ± .03 .X ± .1

BREAK ALL SHARP CORNERS & EDGES

DWG SIZE E

TITLE MAIN BOARD, SCHEMATIC A1

CALICO

MODEL 850T 853T 855T DIGITAL OSCILLATOR

CODE IDENT 16067

DWG NO E4850-070 P

SHEET 1 OF 1

# REPLACEABLE PARTS

## 7.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident number (see Appendix A for list of manufacturers), and California Instruments' stock number are indicated.

## 7.3 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer's number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with California Instruments, Division of Amstar Technical Products Co., Inc., San Diego, California, 92111-1266.

## 7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "Seq. No." - Sequence number; the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alphanumerical order.

7.3.2 "Component Item No." - This is California Instruments part number. Please use this number when ordering spares.

7.3.3 "Description, Truncated" - A brief description of the item. Abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "Engineering Drawing No." - This is used for one of the following:

a) The document/specification number generated by California Instruments to control the part.

b) The generic part number (military specification or industry accepted standard).

c) The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown (contact California Instruments if the full number is required).

7.3.5 "Vendor" - This is the FSCM code identification (see Appendix A).

7.3.6 "Quan" and "U/M" - The requirements per unit of measure such as: "2 each"; "1 lb."; "4 oz."; or "6 SI" (square inches).

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| A1 | 4850-700-1 | PC ASSY,OSCILLATOR | 4850-700 REV U | 16067 | 1.0 | EA |
| R1 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| 12 | 110698-1 | PANEL,FRONT W/4850-100 | 4850-200-1 | 16067 | 1.0 | EA |
| 14 | 110699 | FRAME,PLUG-IN | 4850-201-7 | 16067 | 2.0 | EA |
| 16 | 210650 | KNOB,BLK,CLR SKT *-CL | PS-70TSL-2-BLK* | 21604 | 4.0 | EA |
| 18 | 210191 | KNOB,BLK,IND | PS-70D-2-BLK | 21604 | 1.0 | EA |
| 20 | 210187 | NUT,HEX,NKL,3/8-32 | 1199 | 83330 | 6.0 | EA |
| 23 | FS1013 | SCREW,PNH,S/S,4-40X3/8 | MS51957-15 | 96906 | 1.0 | EA |
| 24 | FS1083 | SCREW,CTG,PNH,CAD,#4X3/8 | #4X3/8 TYPE B | 81349 | 8.0 | EA |
| 25 | 210076 | INSULATOR,SHLDR,NYL,#4 | NY04-040 | 08289 | 1.0 | EA |
| 26 | FS1072 | WASHER,SPLT,S/S,#4 | MS35338-135 | 96906 | 5.0 | EA |
| 27 | FS1066 | NUT,HEX,S/S,4-40 | MS35649-244 | 96906 | 1.0 | EA |
| 28 | 570128 | POT,PNL,10K,1/2W,PREC | B4010-012-1 | 16067 | 1.0 | EA |
| 30 | 240478 | SWITCH,RTRY,3 3POS | 47862-5M(REV A) | 82104 | 1.0 | EA |
| 32 | 210474 | INSULATOR,RECT,MICA | 4673 | 91833 | 1.0 | EA |
| 33 | FS4001 | THERMAL COMPOUND | 351 | 13103 | .1 | OZ |
| 34 | 240325 | FSTNR,CAPTIVE SCREW | 51-28-506-24 | 94222 | 2.0 | EA |
| 35 | 240233 | KNOB,BLK | PS-70-2-BLK | 21604 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|---|
| A1 | 4850-700-1 | PC ASSY,OSCILLATOR | | 4850-700 REV U | 16067 | 1.0 | EA |
| A2 | 4850-702-1 | PC ASSY,PHASE | | 4850-702 REV E1 | 16067 | 1.0 | EA |
| R1 | 510068 | RES,CARB,1/4W,4.7K OHM | | RC07GF472J | 81349 | 1.0 | EA |
| 12 | 110698-1 | PANEL,FRONT W/4850-100 | | 4850-200-1 | 16067 | 1.0 | EA |
| 14 | 110699 | FRAME,PLUG-IN | | 4850-201-7 | 16067 | 2.0 | EA |
| 16 | 210650 | KNOB,BLK,CLR SKT | *-CL | PS-70TSL-2-BLK* | 21604 | 4.0 | EA |
| 18 | 210191 | KNOB,BLK,IND | | PS-70D-2-BLK | 21604 | 2.0 | EA |
| 20 | 210187 | NUT,HEX,NKL,3/8-32 | | 1199 | 83330 | 6.0 | EA |
| 23 | FS1013 | SCREW,PNH,S/S,4-40X3/8 | | MS51957-15 | 96906 | 1.0 | EA |
| 24 | FS1083 | SCREW,CTG,PNH,CAD,#4X3/8 | | #4X3/8 TYPE B | 81349 | 8.0 | EA |
| 25 | 210076 | INSULATOR,SHLDR,NYL,#4 | | NY04-040 | 08289 | 1.0 | EA |
| 26 | FS1072 | WASHER,SPLT,S/S,#4 | | MS35338-135 | 96906 | 5.0 | EA |
| 27 | FS1066 | NUT,HEX,S/S,4-40 | | MS35649-244 | 96906 | 1.0 | EA |
| 28 | 570128 | POT,PNL,10K,1/2W,PREC | | B4010-012-1 | 16067 | 1.0 | EA |
| 30 | 240478 | SWITCH,RTRY,3 3POS | | 47862-5M(REV A) | 82104 | 1.0 | EA |
| 32 | 210474 | INSULATOR,RECT,MICA | | 4673 | 91833 | 1.0 | EA |
| 33 | FS4001 | THERMAL COMPOUND | | 351 | 13103 | .1 | OZ |
| 34 | 240325 | FSTNR,CAPTIVE SCREW | | 51-28-506-24 | 94222 | 2.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| A1 | 4850-700-2 | PC ASSY,OSCILLATOR | 4850-700 REV U | 16067 | 1.0 | EA |
| R29 | 570128 | POT,PNL,10K,1/2W,PREC | B4010-012-1 | 16067 | 1.0 | EA |
| 12 | 110715-2 | PANEL,FRONT W/4850-101 | 4850-200-2 | 16067 | 1.0 | EA |
| 14 | 110699 | FRAME,PLUG-IN | 4850-201-7 | 16067 | 2.0 | EA |
| 18 | 240233 | KNOB,BLK | PS-70-2-BLK | 21604 | 1.0 | EA |
| 20 | 210187 | NUT,HEX,NKL,3/8-32 | 1199 | 83330 | 1.0 | EA |
| 23 | FS1013 | SCREW,PNH,S/S,4-40X3/8 | MS51957-15 | 96906 | 1.0 | EA |
| 24 | FS1083 | SCREW,CTG,PNH,CAD,#4X3/8 | #4X3/8 TYPE B | 81349 | 8.0 | EA |
| 25 | 210076 | INSULATOR,SHLDR,NYL,#4 | NY04-040 | 08289 | 1.0 | EA |
| 26 | FS1072 | WASHER,SPLT,S/S,#4 | MS35338-135 | 96906 | 5.0 | EA |
| 27 | FS1066 | NUT,HEX,S/S,4-40 | MS35649-244 | 96906 | 1.0 | EA |
| 32 | 210474 | INSULATOR,RECT,MICA | 4673 | 91833 | 1.0 | EA |
| 33 | FS4001 | THERMAL COMPOUND | 351 | 13103 | .1 | OZ |
| 34 | 240325 | FSTNR,CAPTIVE SCREW | 51-28-506-24 | 94222 | 2.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| A1 | 4850-700-2 | PC ASSY,OSCILLATOR | 4850-700 REV U | 16067 | 1.0 | EA |
| A2 | 4850-702-1 | PC ASSY,PHASE | 4850-702 REV E1 | 16067 | 1.0 | EA |
| R29 | 570128 | POT,PNL,10K,1/2W,PREC | B4010-012-1 | 16067 | 1.0 | EA |
| 12 | 110715 | PANEL,FRONT | 4850-200-9 | 16067 | 1.0 | EA |
| 14 | 110699 | FRAME,PLUG-IN | 4850-201-7 | 16067 | 2.0 | EA |
| 18 | 240233 | KNOB,BLK | PS-70-2-BLK | 21604 | 1.0 | EA |
| 20 | 210187 | NUT,HEX,NKL,3/8-32 | 1199 | 83330 | 1.0 | EA |
| 23 | FS1013 | SCREW,PNH,S/S,4-40X3/8 | MS51957-15 | 96906 | 1.0 | EA |
| 24 | FS1083 | SCREW,CTG,PNH,CAD,#4X3/8 | #4X3/8 TYPE B | 81349 | 1.0 | EA |
| 25 | 210076 | INSULATOR,SHLDR,NYL,#4 | NY04-040 | 08289 | 1.0 | EA |
| 26 | FS1072 | WASHER,SPLT,S/S,#4 | MS35338-135 | 96906 | 5.0 | EA |
| 27 | FS1066 | NUT,HEX,S/S,4-40 | MS35649-244 | 96906 | 1.0 | EA |
| 32 | 210474 | INSULATOR,RECT,MICA | 4673 | 91833 | 1.0 | EA |
| 33 | FS4001 | THERMAL COMPOUND | 351 | 13103 | 1.0 | OZ |
| 34 | 240325 | FSTNR,CAPTIVE SCREW | 51-28-506-24 | 94222 | 2.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| CR1 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR2 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR3 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR4 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR5 | 250212 | LAMP,LED,RED | LSL-3L | 28564 | 1.0 | EA |
| CR6 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| CR7 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| C1 | 611060 | CAP,CER,1000PF,100V | C22A102K | 71590 | 1.0 | EA |
| C2 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C3 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C4 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C5 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C6 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C7 | 610918 | CAP,VAR,.8-8.5PF | TP9G | 18736 | 1.0 | EA |
| C8 | 610015 | CAP,MICA,50PF,500V | DM15-500J | 72136 | 1.0 | EA |
| C9 | 610004 | CAP,MICA,10PF,500V | CM05C100J03 | 81349 | 1.0 | EA |
| C10 | 610027 | CAP,MICA,100PF,500V | CM05F101J03 | 81349 | 1.0 | EA |
| C11 | 610008 | CAP,MICA,20PF,500V | CM05E200J03 | 81349 | 1.0 | EA |
| C15 | 610802 | CAP,TANT,4.7UF,25V | T362B475M025AS | 05397 | 1.0 | EA |
| C16 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C17 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C19 | 610620 | CAP,MICA,250PF,500V | CM05F251J03 | 81349 | 1.0 | EA |
| C20 | 610050 | CAP,MICA,820PF,300V | CM05F821J03 | 81349 | 1.0 | EA |
| C21 | 611056 | CAP,AL,3300UF,16V | 16T3300 | 30039 | 1.0 | EA |
| C22 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C23 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C24 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C25 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C26 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C27 | 611103 | CAP,CER,.1UF,50V,Z5U | CZ20C104M | 71590 | 1.0 | EA |
| L1 | 590005 | INDUCTOR,RF,200UH | 1537-90 | 99800 | 1.0 | EA |
| Q1 | 330285 | TRANSISTOR,SS,PNP,TO92 | PN2907A | 07263 | 1.0 | EA |
| Q2 | 330285 | TRANSISTOR,SS,PNP,TO92 | PN2907A | 07263 | 1.0 | EA |
| Q3 | 330245 | TRANSISTOR,FET,N,JFET | 2N5246 | 81349 | 1.0 | EA |
| Q4 | 330288 | TRANSISTOR,SS,PNP,TO92 | PE8550 | 07263 | 1.0 | EA |
| Q5 | 330289 | TRANSISTOR,SS,NPN,TO92 | PE8050 | 07263 | 1.0 | EA |
| Q6 | 330284 | TRANSISTOR,SS,NPN,TO92 | PN2222A | 07263 | 1.0 | EA |
| Q7 | 330308 | TRANSISTOR,FET,N,DMOS | CIC376 | 16067 | 1.0 | EA |
| Q8 | 330284 | TRANSISTOR,SS,NPN,TO92 | PN2222A | 07263 | 1.0 | EA |
| R1 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |
| R2 | 510130 | RES,CARB,1/4W,4.7M OHM | RC07GF475J | 81349 | 1.0 | EA |
| R3 | 510090 | RES,CARB,1/4W,39K OHM | RC07GF393J | 81349 | 1.0 | EA |
| R4 | 510130 | RES,CARB,1/4W,4.7M OHM | RC07GF475J | 81349 | 1.0 | EA |
| R5 | 510092 | RES,CARB,1/4W,47K OHM | RC07GF473J | 81349 | 1.0 | EA |
| R6 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |
| R7 | 360241 | RES,ARRAY,DIP,10K | 898-1-R10K-F | 73138 | 1.0 | EA |
| R8 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | U |
|---|---|---|---|---|---|---|
| R10 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R11 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R12 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R13 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R14 | 530004 | RES,CARB,1W,68 OHM | RC32GF680J | 81349 | 1.0 | EA |
| R15 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R16 | 530060 | RES,CARB,1W,47 OHM | RC32GF470J | 81349 | 1.0 | EA |
| R17 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R18 | 560575 | RES,FILM,1/8W,33.2K,1% | RN55D3322F | 81349 | 1.0 | EA |
| R19 | 560747 | RES,FILM,1/8W,8.66K,1% | RN55D8661F | 81349 | 1.0 | EA |
| R20 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R21 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R22 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R23 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R24 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |
| R25 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | EA |
| R26 | 560748 | RES,FILM,1/8W,4.53K,1% | RN55D4531F | 81349 | 1.0 | EA |
| R27 | 360232 | RES,ARRAY,TFLM,DIP,6.8K | 698-3-R6.8K-F | 73138 | 1.0 | EA |
| R28 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R30 | 510037 | RES,CARB,1/4W,220 OHM | RC07GF221J | 81349 | 1.0 | EA |
| R32 | 510084 | RES,CARB,1/4W,22K OHM | RC07GF223J | 81349 | 1.0 | EA |
| R33 | 360154 | RES,ARRAY,SIP,22K | 108A223 | 01121 | 1.0 | EA |
| R35 | 510064 | RES,CARB,1/4W,3.3K OHM | RC07GF332J | 81349 | 1.0 | EA |
| R36 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R39 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R40 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R45 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R46 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| S3 | 240477 | SWITCH,RTRY,10 POS | 11975MP/REL-10 | 82104 | 1.0 | EA |
| S4 | 240477 | SWITCH,RTRY,10 POS | 11975MP/REL-10 | 82104 | 1.0 | EA |
| S5 | 240477 | SWITCH,RTRY,10 POS | 11975MP/REL-10 | 82104 | 1.0 | EA |
| S6 | 240477 | SWITCH,RTRY,10 POS | 11975MP/REL-10 | 82104 | 1.0 | EA |
| TP1 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP2 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP3 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| T1 | 710324 | TRANSFORMER | PC16-640-1 | 08779 | 1.0 | EA |
| U1 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U2 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U3 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U4 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U5 | 360161 | IC,TTL,FF,DUAL | SN74LS74N | 81349 | 1.0 | EA |
| U6 | 360234 | IC,TIMER,DUAL | NE556N | 18324 | 1.0 | EA |
| U7 | 360465 | IC,TTL,INVERT,HEX | 74ALS04 | 81349 | 1.0 | EA |
| U8 | 360235 | IC,TTL,NAND,4-IN,DUAL | SN74LS20N | 81349 | 1.0 | EA |
| U9 | 360032 | IC,VOLTAGE REG,+5,1A | LM340-5T | 27014 | 1.0 | EA |
| U10 | 360236 | IC,VOLTAGE REG,+10,.1A | UA78L10ACLP | 01295 | 1.0 | EA |
| U11 | 360226 | IC,TTL,COUNTER,DEC,DUAL | SN74LS390N | 81349 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| U12 | 360237 | IC,OP-AMP,PREC | CA3193E | 18722 | 1.0 | EA |
| U13 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U14 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U15 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U16 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U17 | CIC207-3 | IC,TTL,PROM,256X4 | CIC207-3 | 16067 | 1.0 | EA |
| U18 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U19 | CIC207-2 | IC,TTL,PROM,256X4 | CIC207-2 | 16067 | 1.0 | EA |
| U20 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| U21 | 360240 | IC,DAC,8-BIT,.19% | DAC-08EN | 18324 | 1.0 | EA |
| U22 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| Y1 | 250332 | CRYSTAL,10.2M,.005% | HC33U PARALLEL* | 54363 | 1.0 | EA |
| 7 | 160306 | PWB,OSCILLATOR | 4850-750-1 | 16067 | 1.0 | EA |
| 150 | 230057 | SOCKET,DIP,16 PIN | ICO-163-S8-T | 06776 | 2.0 | EA |
| 152 | 240294 | SOCKET,XSTR,4 PIN,TO5/18 | 05-3308 | 83486 | 1.0 | EA |
| 154 | 120027 | DECAL,HIGH VOLTAGE 2X.7" | DANGER | 16067 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| CR1 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR2 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR3 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR4 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR6 | 310227 | DIODE,SWNG,75V,.5W,DO35 | 1N4148 | 81349 | 1.0 | EA |
| CR7 | 310227 | DIODE,SWNG,75V,.5W,DO35 | 1N4148 | 81349 | 1.0 | EA |
| C5 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C6 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C7 | 610918 | CAP,VAR,.8-8.5PF | TP9G | 18736 | 1.0 | EA |
| C8 | 610015 | CAP,MICA,50PF,500V | DM15-500J | 72136 | 1.0 | EA |
| C9 | 610004 | CAP,MICA,10PF,500V | CM05C100J03 | 81349 | 1.0 | EA |
| C10 | 610027 | CAP,MICA,100PF,500V | CM05F101J03 | 81349 | 1.0 | EA |
| C11 | 610008 | CAP,MICA,20PF,500V | CM05E200J03 | 81349 | 1.0 | EA |
| C15 | 610802 | CAP,TANT,4.7UF,25V | T362B475M025AS | 05397 | 1.0 | EA |
| C16 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C17 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C19 | 610620 | CAP,MICA,250PF,500V | CM05F251J03 | 81349 | 1.0 | EA |
| C20 | 610050 | CAP,MICA,820PF,300V | CM05F821J03 | 81349 | 1.0 | EA |
| C21 | 611056 | CAP,AL,3300UF,16V | 16T3300 | 30039 | 1.0 | EA |
| C22 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C23 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C24 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C25 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C26 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C27 | 611103 | CAP,CER,.1UF,50V,Z5U | CZ20C104M | 71590 | 1.0 | EA |
| L1 | 590005 | INDUCTOR,RF,200UH | 1537-90 | 99800 | 1.0 | EA |
| Q3 | 330245 | TRANSISTOR,FET,N,JFET | 2N5246 | 81349 | 1.0 | EA |
| Q4 | 330288 | TRANSISTOR,SS,PNP,TO92 | PE8550 | 07263 | 1.0 | EA |
| Q5 | 330289 | TRANSISTOR,SS,NPN,TO92 | PE8050 | 07263 | 1.0 | EA |
| Q7 | 330308 | TRANSISTOR,FET,N,DMOS | CIC376 | 16067 | 1.0 | EA |
| Q8 | 330284 | TRANSISTOR,SS,NPN,TO92 | PN2222A | 07263 | 1.0 | EA |
| R7 | 360241 | RES,ARRAY,DIP,10K | 898-1-R10K-F | 73138 | 1.0 | EA |
| R8 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R10 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R11 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R12 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R14 | 530004 | RES,CARB,1W,68 OHM | RC32GF680J | 81349 | 1.0 | EA |
| R15 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R16 | 530068 | RES,CARB,1W,47 OHM | RC32GF470J | 81349 | 1.0 | EA |
| R17 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R18 | 560575 | RES,FILM,1/8W,33.2K,1% | RN55D3322F | 81349 | 1.0 | EA |
| R19 | 560747 | RES,FILM,1/8W,8.66K,1% | RN55D8661F | 81349 | 1.0 | EA |
| R20 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R21 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R22 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R23 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R24 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |

PARENT ITEM NO.
4850-700-2

PC ASSY,OSCILLATOR
ENGR DRAW NO. 4850-700 REV U



| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | |
|---|---|---|---|---|---|---|
| R25 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | |
| R26 | 560748 | RES,FILM,1/8W,4.53K,1% | RN55D4531F | 81349 | 1.0 | |
| R27 | 360232 | RES,ARRAY,TFLM,DIP,6.8K | 698-3-R6.3K-F | 73138 | 1.0 | |
| R28 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | |
| R32 | 510084 | RES,CARB,1/4W,22K OHM | RC07GF223J | 81349 | 1.0 | |
| R33 | 360154 | RES,ARRAY,SIP,22K | 108A223 | 01121 | 1.0 | |
| R35 | 510064 | RES,CARB,1/4W,3.3K OHM | RC07GF332J | 81349 | 1.0 | |
| R36 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | |
| R39 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | |
| R45 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | |
| R46 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | |
| S1 | 240475 | SWITCH,DIP,8 SECT | 206-8-LPST | 71450 | 1.0 | |
| S2 | 240475 | SWITCH,DIP,8 SECT | 206-8-LPST | 71450 | 1.0 | |
| TP1 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | |
| TP2 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | |
| TP3 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | |
| T1 | 710324 | TRANSFORMER | PC16-640-1 | 08779 | 1.0 | |
| U1 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | |
| U2 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | |
| U3 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | |
| U4 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | |
| U7 | 360159 | IC,TTL,INVERT,HEX | SN74LS04N | 81349 | 1.0 | |
| U8 | 360235 | IC,TTL,NAND,4-IN,DUAL | SN74LS20N | 81349 | 1.0 | |
| U9 | 360032 | IC,VOLTAGE REG,+5,1A | LM340-5T | 27014 | 1.0 | |
| U10 | 360236 | IC,VOLTAGE REG,+10,.1A | UA78L10ACLP | 01295 | 1.0 | |
| U11 | 360226 | IC,TTL,COUNTER,DEC,DUAL | SN74LS390N | 81349 | 1.0 | |
| U12 | 360237 | IC,OP-AMP,PREC | CA3193E | 18722 | 1.0 | |
| U13 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | |
| U14 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | |
| U15 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | |
| U16 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | |
| U17 | CIC207-3 | IC,TTL,PROM,256X4 | CIC207-3 | 16067 | 1.0 | |
| U18 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | |
| U19 | CIC207-2 | IC,TTL,PROM,256X4 | CIC207-2 | 16067 | 1.0 | |
| U20 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | |
| U21 | 360240 | IC,DAC,8-BIT,.19% | DAC-08EN | 18324 | 1.0 | |
| U22 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | |
| Y1 | 250332 | CRYSTAL,10.2M,.005% | HC33U PARALLEL* | 54363 | 1.0 | |
| 7 | 160306 | PWB,OSCILLATOR | 4850-750-1 | 16067 | 1.0 | |
| 150 | 230057 | SOCKET,DIP,16 PIN | ICO-163-S8-T | 06776 | 2.0 | |
| 152 | 240294 | SOCKET,XSTR,4 PIN,TO5/18 | 05-3308 | 83486 | 1.0 | |
| 154 | 120027 | DECAL,HIGH VOLTAGE 2X.7" | DANGER | 16067 | 1.0 | |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| C1 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C2 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C4 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C5 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C6 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C8 | 610050 | CAP,MICA,820PF,300V | CM05F821J03 | 81349 | 1.0 | EA |
| C9 | 610620 | CAP,MICA,250PF,500V | CM05F251J03 | 81349 | 1.0 | EA |
| C10 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C11 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| J1 | 250339 | CABLE ASSY,FLEX,15COND6" | J-15-24-1-U-6.0 | 08261 | 1.0 | EA |
| Q1 | 330308 | TRANSISTOR,FET,N,DMOS | CIC376 | 16067 | 1.0 | EA |
| R1 | 360241 | RES,ARRAY,DIP,10K | 898-1-R10K-F | 73138 | 1.0 | EA |
| R2 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R3 | 360232 | RES,ARRAY,TFLM,DIP,6.8K | 698-3-R6.8K-F | 73138 | 1.0 | EA |
| R4 | 560716 | RES,FILM,1/8W,4.64K,1% | RN55D4641F | 81349 | 1.0 | EA |
| R5 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R6 | 360232 | RES,ARRAY,TFLM,DIP,6.8K | 698-3-R6.8K-F | 73138 | 1.0 | EA |
| R7 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | EA |
| R8 | 560575 | RES,FILM,1/8W,33.2K,1% | RN55D3322F | 81349 | 1.0 | EA |
| R9 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R10 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R11 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | EA |
| R12 | 560747 | RES,FILM,1/8W,8.66K,1% | RN55D8661F | 81349 | 1.0 | EA |
| R13 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |
| R14 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | EA |
| R15 | 570258 | POT,1T,PC,200 OHM | 63P201 | 02111 | 1.0 | EA |
| R16 | 510084 | RES,CARB,1/4W,22K OHM | RC07GF223J | 81349 | 1.0 | EA |
| R17 | 360154 | RES,ARRAY,SIP,22K | 108A223 | 01121 | 1.0 | EA |
| R66 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R70 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R73 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R74 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R75 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| TP3 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP5 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP12 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| U1 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U2 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U3 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U4 | CIC207-3 | IC,TTL,PROM,256X4 | CIC207-3 | 16067 | 1.0 | EA |
| U5 | CIC207-2 | IC,TTL,PROM,256X4 | CIC207-2 | 16067 | 1.0 | EA |
| U6 | 360156 | IC,TTL,NAND,2-IN,QUAD | SN74LS00N | 81349 | 1.0 | EA |
| U7 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| U8 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| U9 | 360240 | IC,DAC,8-BIT,.19% | DAC-08EN | 18324 | 1.0 | EA |
| U10 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U11 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |

PARENT ITEM NO.
4850-702-1

PC ASSY,PHASE
ENGR DRAW NO. 4850-702 REV E1



| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY |
|---|---|---|---|---|---|
| U12 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 |
| 7 | 160328 | PWB,PHASE/SERVO | 4850-702-7 | 16067 | 1.0 |
| 151 | 240294 | SOCKET,XSTR,4 PIN,TO5/18 | 05-3308 | 83486 | 1.0 |
| 152 | 230057 | SOCKET,DIP,16 PIN | ICO-163-S8-T | 06776 | 2.0 |

# SECTION VIII
# OPTIONS

8-1 GENERAL

8-2 This section of the manual contains information regarding all available options.

# MANUAL ADDENDUM

## 850T/855T/853T - Option A

The option A indicates that the output has a Frequency Accuracy of 0.0001% with stability of 1PPM per degree C average temperature coefficient from 10 degrees C to 50 degrees C.

# MANUAL ADDENDUM

## 1.0 MODEL NUMBER DESCRIPTION

All oscillators in the 85XT Series have a number that describes the frequency selection, number of servoed or unservoed outputs and method of amplitude control.
The first designation is either the 850T, 853T or 855T.

## 1.1 PHASE DESIGNATION

The next portion of the oscillator model number indicates the number of unservoed outputs. If the number of phases is followed by the designator "S", the outputs are servoed.

For example:

| | |
|---|---|
| XXX-1 | Single Phase |
| XXX-2 | Two Phase (Phase C leading A by 90°) |
| XXX-3 | Three Phase |
| XXX-3D | Three-Phase Open Delta (Phase C leading A by 60°) |
| XXX-1S | Single Phase servoed |

## 1.2 AMPLITUDE PROGRAM

The last designator, if present, indicates the optional methods of externally programming the output amplitude.

| | |
|---|---|
| XXX-XX-RPV | indicates programming by DC voltage. |
| XXV-XX-RPR | indicates programming by resistance. |

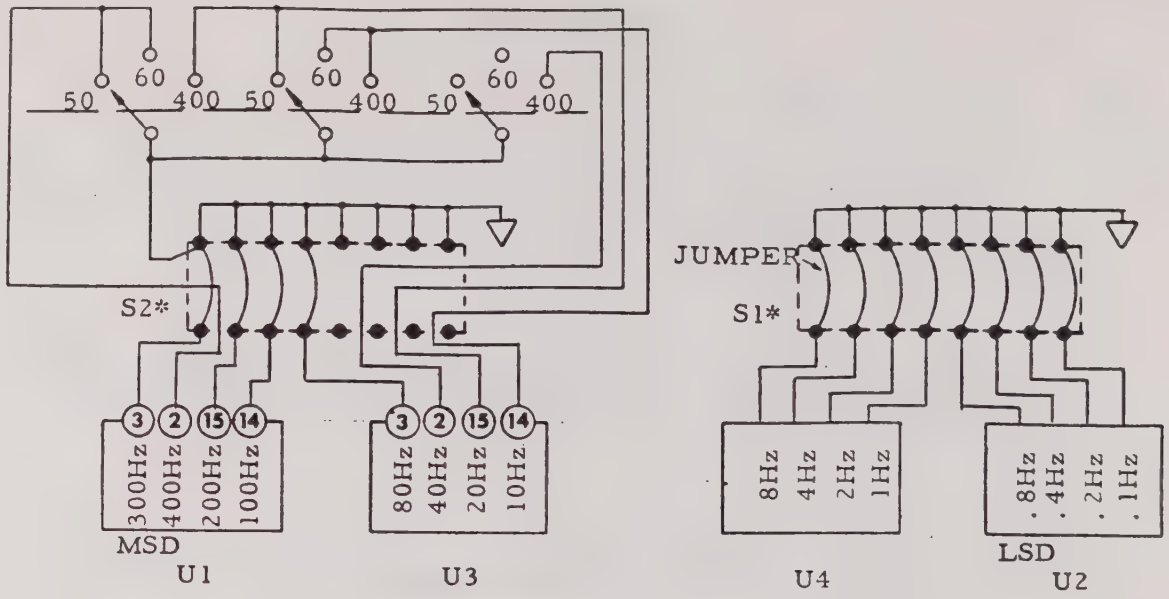
## 2.0 MODEL 853T

## 2.1 GENERAL

The 853T oscillator is identical to an 855T, except any of three frequencies--50Hz, 60Hz, and 400Hz--can be selected.

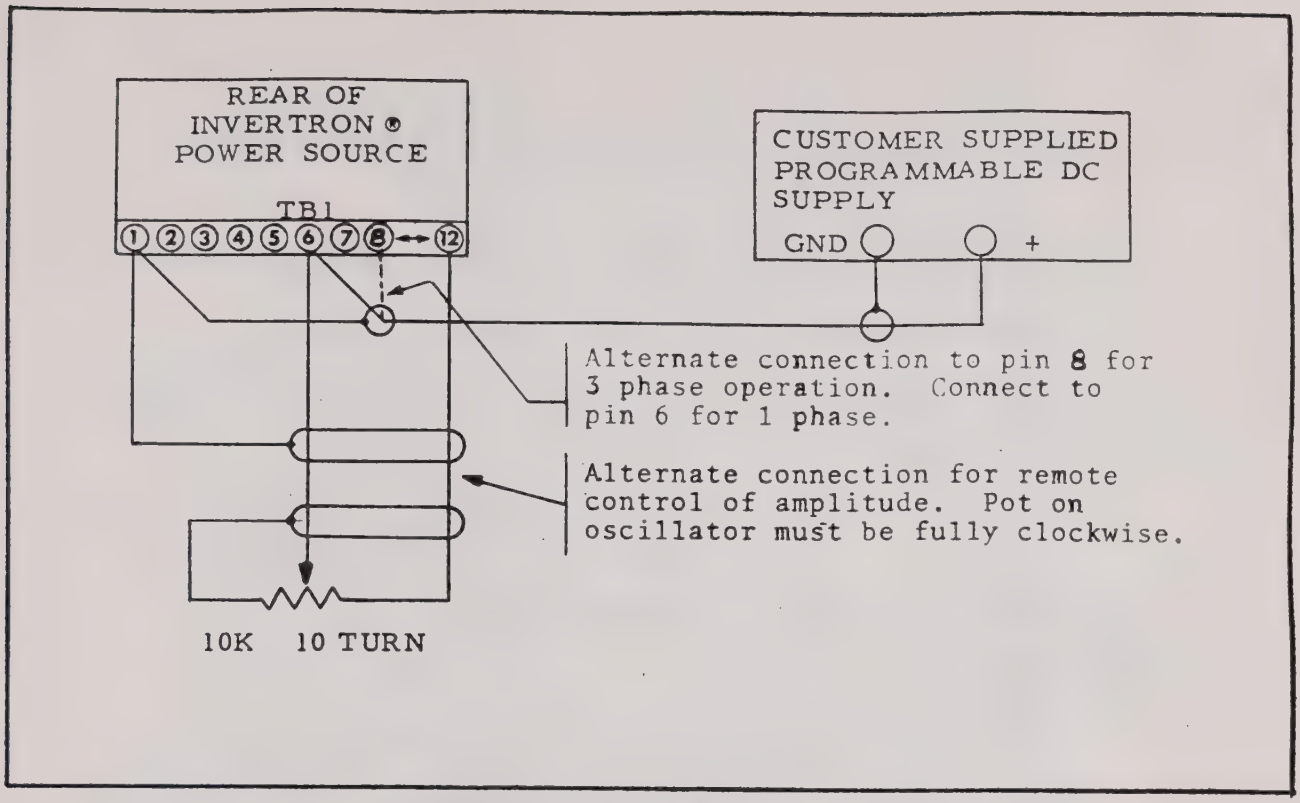
## 2.2 THEORY OF OPERATION

Refer to Figure 6-4 in the standard 855T Instruction Manual. DIP switches S1 and S2 are removed for the 853T. Switch S1 is replaced by jumpers and S2 is wired to the front panel 50, 60, 400Hz selector switch. Refer to Figure 1 of this addendum. Range jumper W3 is installed instead of W1 to enable the 999.9Hz frequency range.




*NOTE:
S1 and S2 are removed to allow wiring to frequency selector switch 22Ω DIP resistor may be substituted for jumpers at S1 .

853T FREQUENCY PROGRAMING
FIGURE 1


REAR OF
INVERTRON ®
POWER SOURCE
TB1
1 2 3 4 5 6 7 8 12
CUSTOMER SUPPLIED
PROGRAMMABLE DC
SUPPLY
GND
+
Alternate connection to pin 8 for 3 phase operation. Connect to pin 6 for 1 phase.
Alternate connection for remote control of amplitude. Pot on oscillator must be fully clockwise.
10K 10 TURN

CONNECTIONS FOR DC
PROGRAMING
FIGURE 2

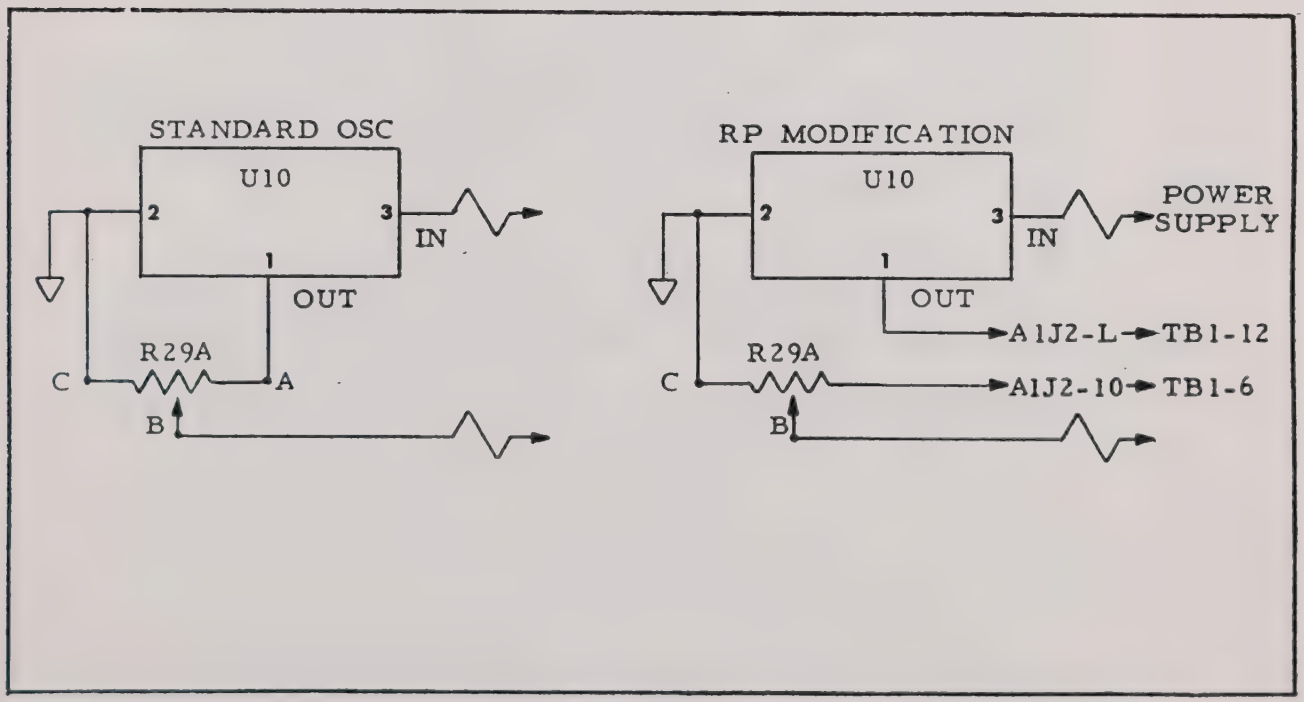



FIGURE 3

## 3.0 RPV OPTION

### 3.1 GENERAL

The RPV option allows the power system's output amplitude to be DC programmable .

### 3.2 SPECIFICATIONS

All standard specifications apply except for the following:

| | |
|---|---|
| AMPLITUDE STABILITY: | Determined by DC programming source. |
| AMPLITUDE TEMPERATURE COEFFICIENT: | Determined by DC programming source. |
| DC PROGRAMMING VOLTAGE: | +30VDC MAX. into 10KΩ impedance<br>+10VDC represents maximum oscillator output (5VRMS) with the oscillator pot full clockwise. |
| SLOW START: | Not functional. |

### 3.3 PROGRAMMING

The DC programming voltage must be applied across pin 6 and pin 1 on TB1 at the rear panel of the power source. Pin 6 must be the positive input. See Figure 2. If a DC voltage greater than +10V is to be used, the oscillator front panel AMPLITUDE control must be reduced to keep the oscillator and power source output within their operating ranges. The power source full scale output is obtained by an output of approximately 5VRMS from the oscillator.

### 3.4 REMOTE GAIN CONTROL

The +10Volt reference is available at pin 12 of TB1 on rear of power source and this may be used in conjunction with a 10KΩ potentiometer to control the output amplitude of the power source. See Figure 2 .

### 3.5 THEORY OF OPERATION

See Main Board schematic number 4850-070. Instead of R29A connecting to A1U10-1, R29A connects to A1J2-10, and A1U10-1 connects to A1J2-12. This removes A1U10, the +10 volt reference, from circuit and allows an external power supply to be substituted. See Figure 3 .

The standard slow start feature is not functional in these versions of the oscillator.

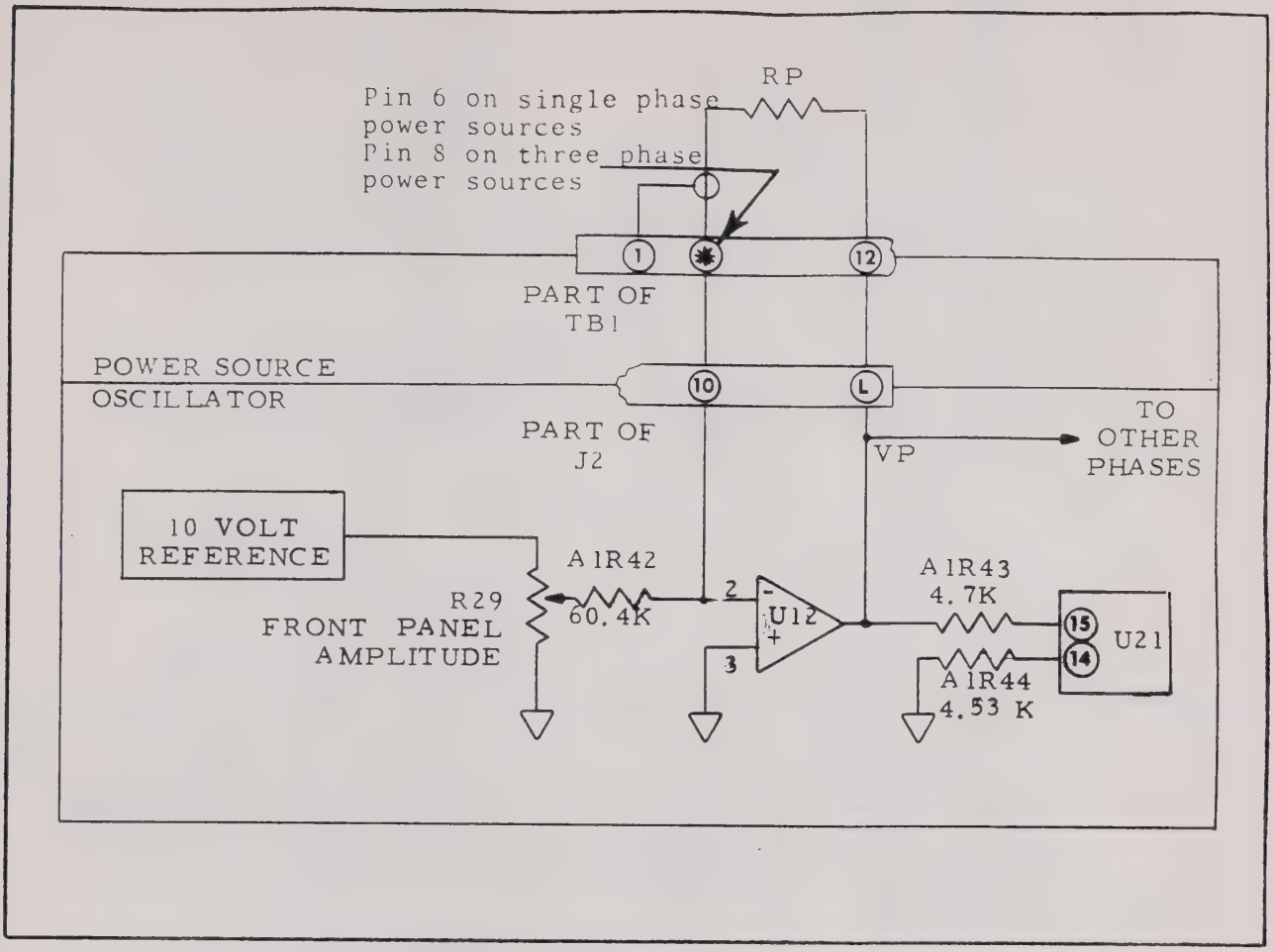



DIAGRAM OF RPR
FIGURE 4

## 4.0 RPR OPTION

### 4.1 GENERAL

The RPR option allows the output amplitude of the power system to be controlled by a variable resistance.

### 4.2 SPECIFICATIONS

| RANGE | AMPLITUDE CONTROL (Ω/V) minimum |
|---|---|
| 135/270 | 444/222 |
| 130/260 | 462/231 |
| 120/240 | 500/250 |

All other specifications are the same as the standard oscillator.

### 4.3 THEORY OF OPERATION

A diagram of the RPR configuration is shown in Figure 4. The operational amplifier A1U12 is operating in the inverting mode such that its output voltage Vp is proportional to the remote programming resistance Rp. The remote programming sensitivity can be increased by the setting of the oscillator amplitude control R29. Since the output of the reference amplifier U12 is negative with the RPR configuration, the "-" input of all DAC'S must receive the amplitude programming voltage.

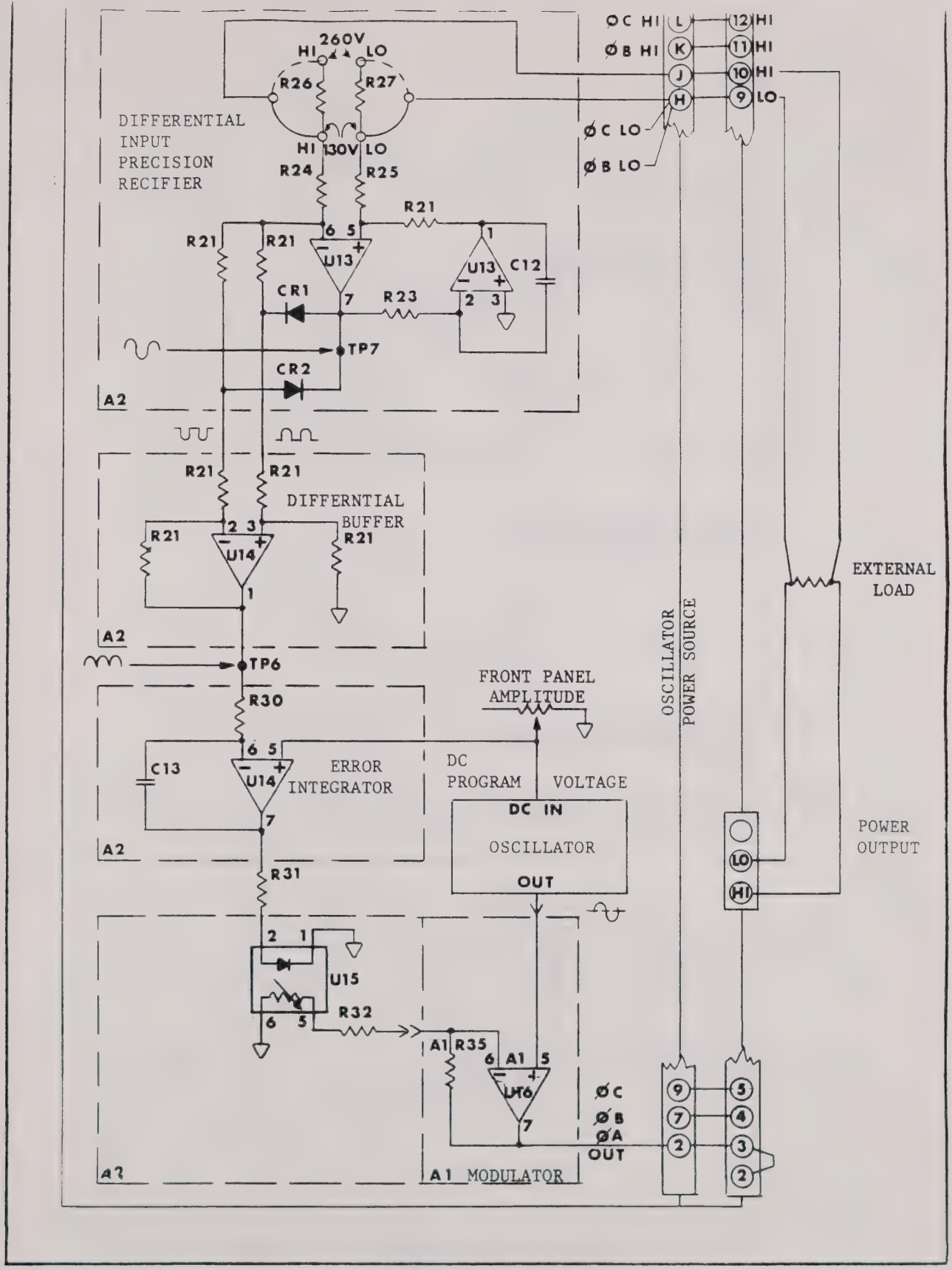
### 4.4 CALIBRATION

Select a resistor that represents the full scale output voltage of the power source. (ex: Range=120, Rp=120X.5K=60K)
Connect this resistor across terminals 6 and 12 of TB1 on the rear of the single phase power source or pins 8 and 12 on a three-phase source. While monitoring the power source output voltage, adjust the oscillator amplitude control and power source gain control to 120.0 volts .

## 5.0 SERVO OPTION

### 5.1 GENERAL

All Model 85X series oscillators can be used with the servo option. The servo option is not available with either the RPV or RPR options. The servo option allows the power source output to be precisely regulated at a distance from the power source.




SERVO CONFIGURATION
FIGURE 5

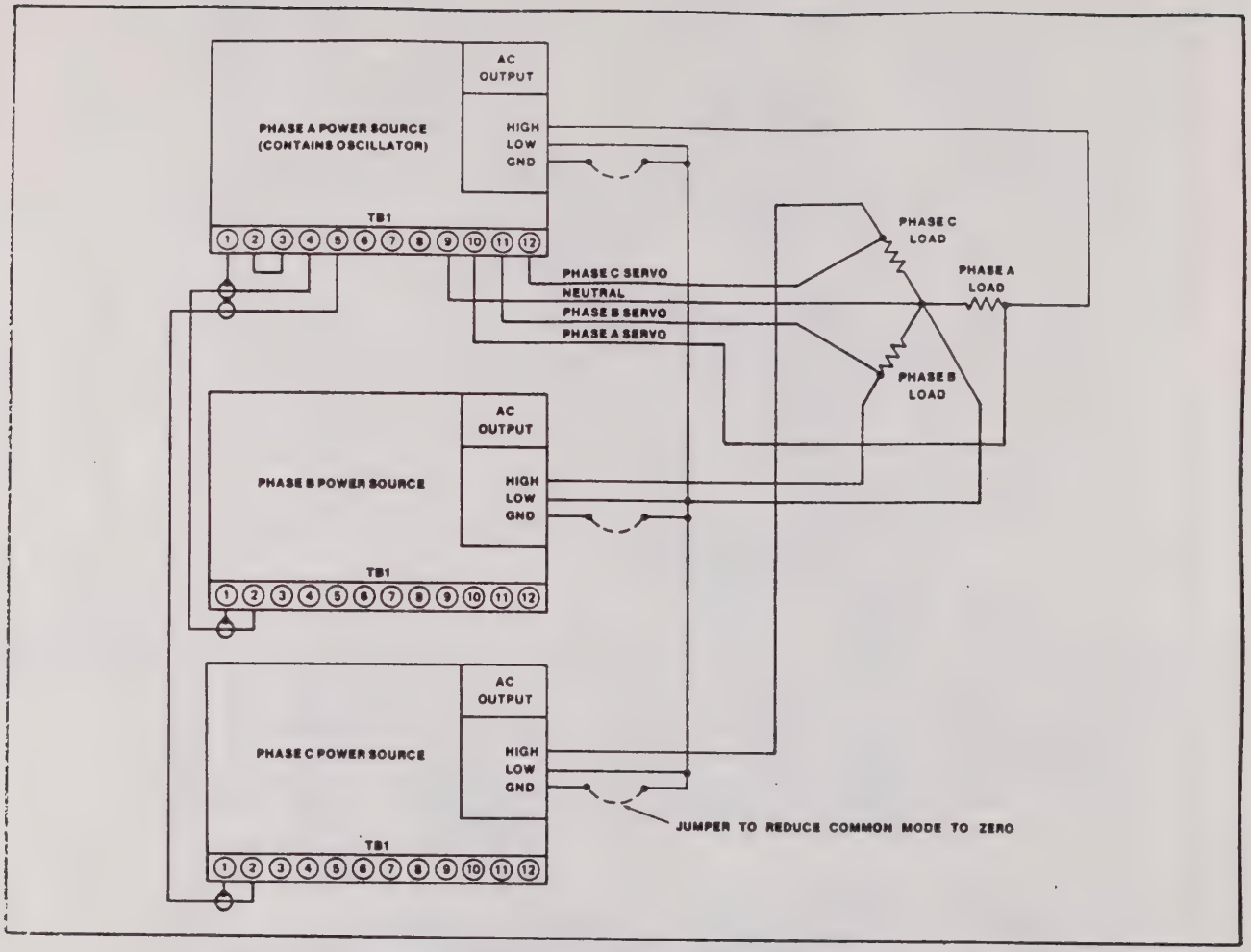



Figure 6_A Polyphase Power Source System Connections Using Individual Units.

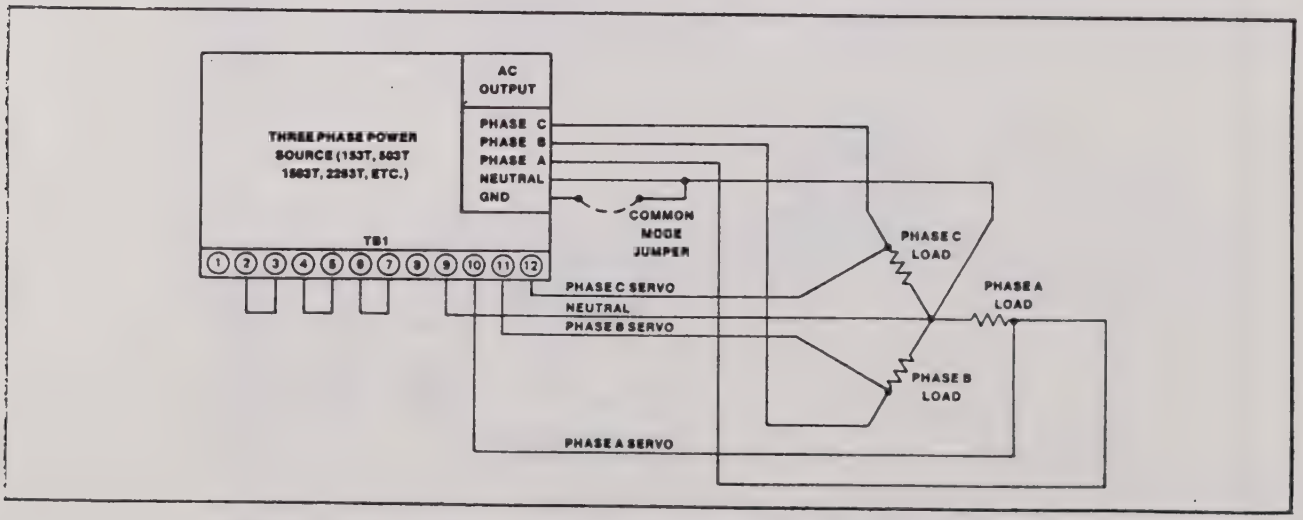



Figure 6 B Polyphase Power Source System Connections Using Single Unit.

## 5.2 THEORY OF OPERATION

The operation of the Phase A servo is shown in Figure 5. The operation of the Phase Band C servoes is identical to that of Phase A. The output amplitude of the power system is set by the oscillator front panel AMPLITUDE adjustment. This DC voltage is sent to the oscillator which generates a sinewave with an amplitude proportional to the DC program voltage. The oscillator output is routed through the MODULATOR and then to the power source which amplifies the signal to the appropriate level. The amplitude of the voltage is sensed across the load by differential input of the PRECISION RECTIFIER. The two half-wave outputs of the PRECISION RECTIFIER are changed to positive full wave by the DIFFERENTIAL BUFFER. The DIFFERENTIAL BUFFER output at TP6 is a voltage with a DC component proportional to the voltage sensed across the load. The DC component of this voltage is compared with the DC program voltage at the input of the ERROR INTEGRATOR. The ERROR INTEGRATOR output drives the MODULATOR to increase or decrease the drive to the power source to keep the DC component of the sense voltage equal to the DC program voltage.

## 5.3 SERVO CALIBRATION

5.3.1 With the servo inputs disconnected, adjust the distortion and amplitude controls identical to the procedure for an unservoed oscillator.

5.3.2 Short the common mode voltage by shorting the servo neutral input to analog common. (short TB1-1 to TB1-9)

5.3.3 Set the oscillator front panel AMPLITUDE adjustment to its maximum clockwise position. Increase the front panel GAIN control of each power source until the output of each phase is full scale +10%. (ex: 148V for 135 volt range)

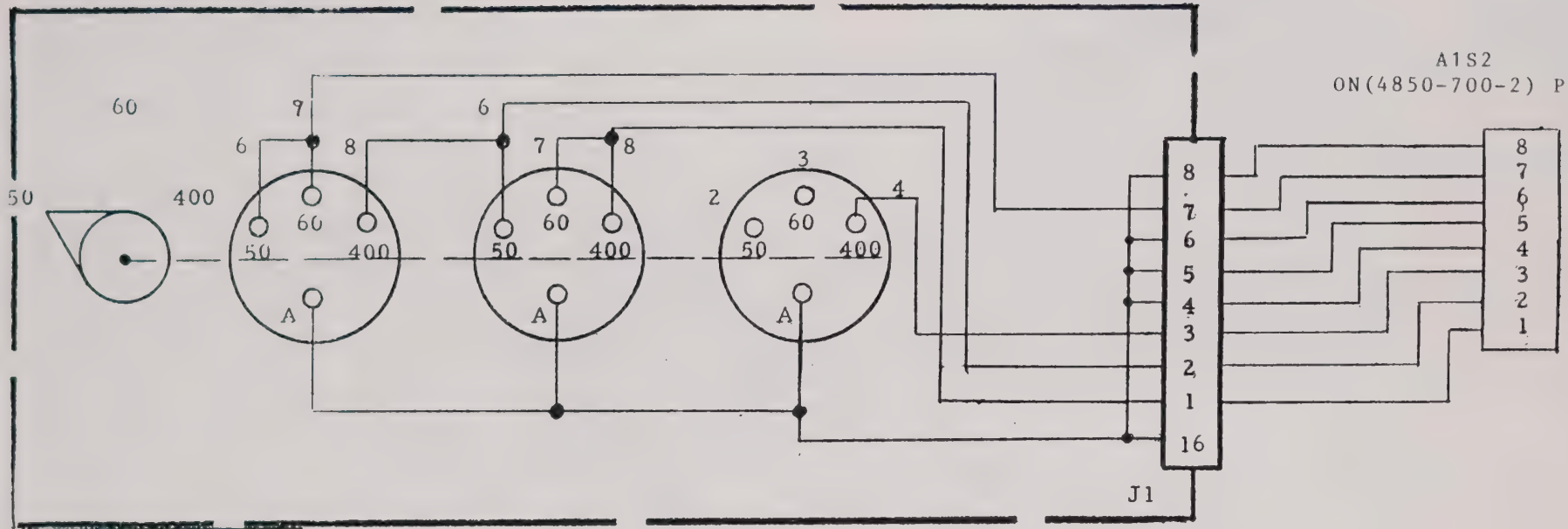
5.3.4 Close the servo loop of each phase by connecting the servo inputs (Pins 9,10,11,12 of TB1) across the load. See Figure 6. Adjust the full scale pot of each to the full scale voltage. See Table 1.

5.3.5 Remove the common mode short added in Step 5.3.2 . TB1-10,11 and 12 are the Phase A, B and C servo sense HI inputs respectively. Alternately short each servo sense HI input and adjust the common mode pot of each phase to the full scale values recorded in Step 5.3.4 .

| PHASE | STEP 5.3.3 OPEN SERVO ADJUSTMENT | STEP 5.3.4 FULL SCALE ADJUSTMENT | STEP 5.3.5 COMMON MODE ADJUSTMENT |
|---|---|---|---|
| A | PHASE A SOURCE GAIN CONTROL | A2 R20 | A2 R22 |
| B | PHASE B SOURCE GAIN CONTROL | A2 R33 | A2 R35 |
| C | PHASE C SOURCE GAIN CONTROL | A2 R46 | A2 R48 |

TABLE 1

853T
50/60/400HZ




4850-705-1 | A4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30′ | BREAK ALL SHARP CORNERS & EDGES / MACH SURFACES ✓ | DWG B SIZE | TITLE FREQUENCY SELECT-SCHEMATIC DIAGRAM | | | | CALICO CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA |
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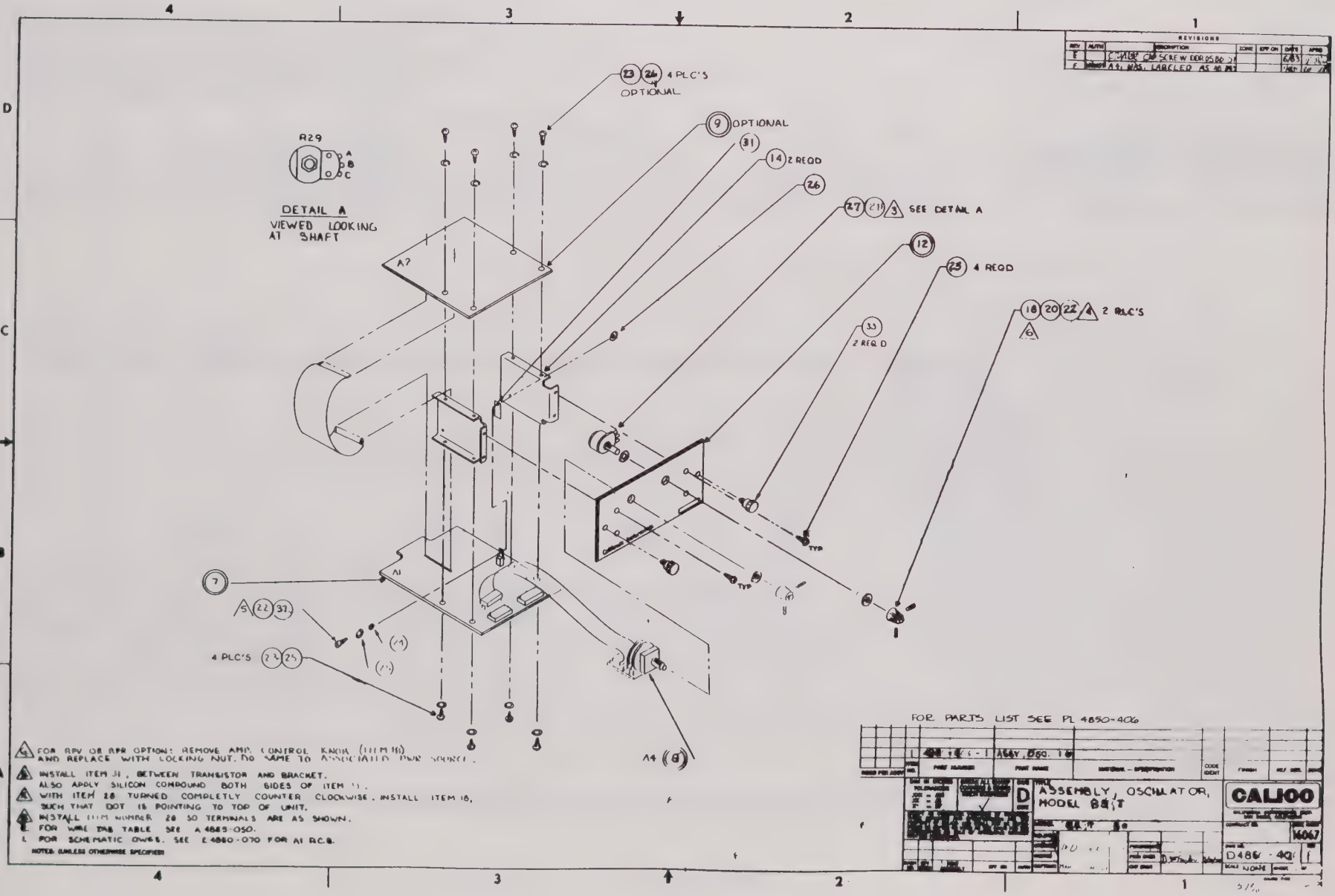
| | | | RELEASE | | | | |
| | | | CHECKER W Duchek | 12/7/79 | PURCHASING | | DWG NO. 4850-076 / REV — |
| | | | DESIGN | | PROJ ENGR | D McFadden 12/21 | |
| DASH NO. / QTY REQD / NEXT ASSEMBLY / EFF ON / AUTH | | | DRFTSMN M.SANCHEZ | 11-29-79 | CHF ENGR | | SCALE NONE / SHEET 1 OF 1 |




FOR PARTS LIST SEE PL 4850-406

4. FOR RPV OR RPR OPTION: REMOVE AMP. CONTROL KNOB (ITEM 18) AND REPLACE WITH LOCKING NUT. DO SAME TO ASSOCIATED PWR SOURCE.
3. INSTALL ITEM 31, BETWEEN TRANSISTOR AND BRACKET. ALSO APPLY SILICON COMPOUND BOTH SIDES OF ITEM 31.
2. WITH ITEM 28 TURNED COMPLETLY COUNTER CLOCKWISE, INSTALL ITEM 18, SUCH THAT DOT IS POINTING TO TOP OF UNIT.
1. INSTALL ITEM NUMBER 28 SO TERMINALS ARE AS SHOWN.
E. FOR WIRE DAB TABLE SEE A 4865-050.
L. FOR SCHEMATIC DWGS. SEE E 4880-070 FOR A1 P.C.B.

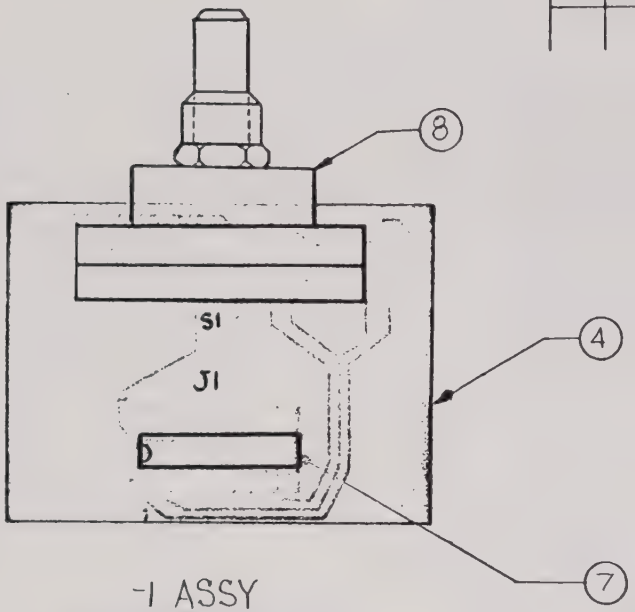
NOTES: UNLESS OTHERWISE SPECIFIED

| REVISIONS | | | | | | |
|---|---|---|---|---|---|---|
| REV | AUTH | DESCRIPTION | ZONE | ECP OR | DATE | APPD |
| F | | E-RING CAP SCREW DDR0580 2 | | | 6/83 | |
| E | | A3, MASS. LABELED AS NO MK3 | | | | |

| | | | |
|---|---|---|---|
| ASSEMBLY, OSCILLATOR, MODEL 881T | | CALIOO | |
| SIZE D | | 14067 | |
| D486 - 406 | | SCALE NONE | SHEET 1 |

| — | SDL-0937 |
|---|---|

| REVISIONS | | | | | | |
|---|---|---|---|---|---|---|
| REV | AUTH | DESCRIPTION | ZONE | EFF ON | DATE | APPD |
| | | | | | | |




-1 ASSY

| REQD PER ASSY | ITEM NO. | PART NUMBER | PART NAME | MATERIAL — SPECIFICATION | CODE IDENT | FINISH | REF DES | ZONE |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

DIM IN INCHES
TOLERANCES
.XXX = .010
.XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES
✓

DWG SIZE B

TITLE FREQUENCY SELECT-
P.C. BOARD ASSEMBLY

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MODEL 853T

| | | | | | |
|---|---|---|---|---|---|
| RELEASE | | | PURCHASING | | |
| CHECKER | [illegible] | 11/79 | PROJ ENGR | D. M. Ford | 12/79 |
| DESIGN | | | CHF ENGR | | |
| DRFTSMN | M. SANCHEZ | 11/13/79 | | | |

| DASH NO | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH |
|---|---|---|---|---|
| | | | | |

CALICO
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

CONTRACT NO
CODE IDENT 16067

DWG NO. 4850-705
REV —

SCALE 2/1
SHEET 2 OF 4

1. CLAD SHOWN IS FAR SIDE.

NOTES: (UNLESS OTHERWISE SPECIFIED)

CALICO F 101

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| A1 | 4850-700-3 | PC ASSY,OSCILLATOR | 4850-700 REV U | 16067 | 1.0 | EA |
| A4 | 4850-705-1 | PC ASSY,50/60/400HZ | 4850-705 REV 0 | 16067 | 1.0 | EA |
| R29 | 570128 | POT,PNL,10K,1/2W,PREC | B4010-012-1 | 16067 | 1.0 | EA |
| 12 | 110738-1 | PANEL,FRONT W/4850-106 | 4850-208-1 | 16067 | 1.0 | EA |
| 14 | 110699 | FRAME,PLUG-IN | 4850-201-7 | 16067 | 2.0 | EA |
| 16 | 410275 | CABLE ASSY,RIBBON,4" | 5242-004 | 08261 | 1.0 | EA |
| 18 | 210191 | KNOB,BLK,IND | PS-70D-2-BLK | 21604 | 2.0 | EA |
| 20 | 210187 | NUT,HEX,NKL,3/8-32 | 1199 | 83330 | 2.0 | EA |
| 22 | FS1013 | SCREW,PNH,S/S,4-40X3/8 | MS51957-15 | 96906 | 1.0 | EA |
| 23 | FS1083 | SCREW,CTG,PNH,CAD,#4X3/8 | #4X3/8 TYPE B | 81349 | 9.0 | EA |
| 24 | 210076 | INSULATOR,SHLDR,NYL,#4 | NY04-040 | 08289 | 1.0 | EA |
| 25 | FS1072 | WASHER,SPLT,S/S,#4 | MS35338-135 | 96906 | 5.0 | EA |
| 26 | FS1066 | NUT,HEX,S/S,4-40 | MS35649-244 | 96906 | 1.0 | EA |
| 31 | 210474 | INSULATOR,RECT,MICA | 4673 | 91833 | 1.0 | EA |
| 32 | FS4001 | THERMAL COMPOUND | 351 | 13103 | .1 | OZ |
| 33 | 240325 | FSTNR,CAPTIVE SCREW | 51-28-506-24 | 94222 | 2.0 | EA |

# California Instruments

CODE IDENT 16067

## PARTS LIST

| REF. DES. | MFG. NUMBER | DESCRIPTION | CODE IDENT | CALICO STOCK NUMBER | ITEM NO. |
|---|---|---|---|---|---|
| | 4850-410-1 | RPR OPTION | | | 1 |
| | 4850-410-2 | SQUARE WAVE OPTION | | | 2 |
| | 4850-410-3 | RPR/SQUARE WAVE OPTION | | | 3 |
| ---------- | DELETE FOR | 4850-700 (A1) PCB ---------- | | | 4 |
| C19 | CM05F251J03 | CAPACITOR 250pF 500V | 02799 | 6-102620 | 5 |
| C20 | CMO5F821J03 | CAPACITOR 820pF 500V | 02799 | 6-10050 | 6 |
| R21 | RC07GF103J | RESISTOR .10K 1/4W 5% | 81349 | 5-10076 | 7 |
| R26 | RN55D4531F | RESISTOR 4.53K 1% | 81349 | 5-60748 | 8 |
| R28 | RC07GF472J | RESISTOR 4.7K 1/4W 5% | 81349 | 5-10068 | 9 |
| U12 | LM741EN | OP-AMP | 27014 | 3-60237 | 10 |
| U17 | 4850-011, RED | IC-PROM 256x4 16PIN | 16067 | 3-60109 | 11 |
| U19 | 4850-010, BRN | IC-PROM 256x4 16PIN | 16067 | 3-60109 | 12 |
| ---------- | DELETE FOR | 4850-702 (A2) PCB (IF REQUIRED) ---------- | | | 13 |
| C8 | CMO5F821J03 | CAPACITOR 820pF 500V | 81349 | 6-10050 | 14 |
| C9 | CMO5F251J03 | CAPACITOR 250pF 500V | 81349 | 6-10620 | 15 |
| R4 | RN55C4751F | RESISTOR 4.74K 1/8W 1% | 81349 | 5-60752 | 16 |
| R5 | RC07GF472J | RESISTOR 4.7K 1/4W 5% | 81349 | 5-1068 | 17 |
| U4 | 4850-011, RED | IC-PROM 256x4 16PIN | 16067 | 3-60109 | 18 |
| U5 | 4850-010, BRN | IC-PROM 256x4 16PIN | 16067 | 3-60109 | 19 |
| | | | | | 20 |
| ---------- | ADD TO 4850-700 (A1) PCB ---------- | | | | 21 |
| R42 | RN60E604F | RESISTOR 60.4K 1/8W 1% | 81349 | 5-60492 | 22 |
| R43 | RC07GF472J | RESISTOR 4.7K 1/4W 5% | 81349 | 5-10068 | 23 |
| R44 | RN55D4531F | RESISTOR 4.53K 1% | 81349 | 5-60748 | 24 |
| U12 | LF356N | I.C. | 27014 | 3-60217 | 25 |
| | C19, C20, R26, R28, U17, U19 NOT USED | | | | 26 |
| | | | | | 27 |
| ---------- | ADD TO 4850-702 (A2) PCB (IF REQUIRED) ---------- | | | | 28 |
| R71 | RN55C4751F | RESISTOR 4.75K 1/8W 1% | 81349 | 5-60752 | 29 |
| R72 | RC07GF472J | RESISTOR 4.7K 1/4W 5% | 81349 | 5-10068 | 30 |
| | C8, C9, R4, R5, U4, U5, NOT USED | | | | 31 |
| | | | | | 32 |
| | | | | | 33 |
| | | | | | 34 |
| | | | | | 35 |
| | | | | | 36 |

MODEL 850T/855T/853T | CALICO P/N 4850-410 | ASSY R.D.

TITLE ADD / DELETE PARTS LIST | SHT 2 OF 2

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| CR1 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR2 | 310173 | DIODE,ZNR,16V,.5W,5% | 1N5246B | 04713 | 1.0 | EA |
| CR3 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR4 | 310062 | DIODE,RECT,1A,400V,DO41 | 1N4004 | 81349 | 1.0 | EA |
| CR6 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| CR7 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| C5 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C6 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C7 | 610918 | CAP,VAR,.8-8.5PF | TP9G | 18736 | 1.0 | EA |
| C8 | 610015 | CAP,MICA,50PF,500V | DM15-500J | 72136 | 1.0 | EA |
| C9 | 610004 | CAP,MICA,10PF,500V | CM05C100J03 | 81349 | 1.0 | EA |
| C10 | 610027 | CAP,MICA,100PF,500V | CM05F101J03 | 81349 | 1.0 | EA |
| C11 | 610008 | CAP,MICA,20PF,500V | CM05E200J03 | 81349 | 1.0 | EA |
| C15 | 610802 | CAP,TANT,4.7UF,25V | T362B475M025AS | 05397 | 1.0 | EA |
| C16 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C17 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C19 | 610620 | CAP,MICA,250PF,500V | CM05F251J03 | 81349 | 1.0 | EA |
| C20 | 610050 | CAP,MICA,820PF,300V | CM05F821J03 | 81349 | 1.0 | EA |
| C21 | 611056 | CAP,AL,3300UF,16V | 16T3300 | 30039 | 1.0 | EA |
| C22 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C23 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C24 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C25 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C26 | 610094 | CAP,CER,.01UF,50V | CK103 | 71590 | 1.0 | EA |
| C27 | 611103 | CAP,CER,.1UF,50V,Z5U | CZ20C104M | 71590 | 1.0 | EA |
| L1 | 590005 | INDUCTOR,RF,200UH | 1537-90 | 99800 | 1.0 | EA |
| Q3 | 330245 | TRANSISTOR,FET,N,JFET | 2N5246 | 81349 | 1.0 | EA |
| Q4 | 330288 | TRANSISTOR,SS,PNP,TO92 | PE8550 | 07263 | 1.0 | EA |
| Q5 | 330289 | TRANSISTOR,SS,NPN,TO92 | PE8050 | 07263 | 1.0 | EA |
| Q7 | 330308 | TRANSISTOR,FET,N,DMOS | CIC376 | 16067 | 1.0 | EA |
| Q8 | 330284 | TRANSISTOR,SS,NPN,TO92 | PN2222A | 07263 | 1.0 | EA |
| R7 | 360241 | RES,ARRAY,DIP,10K | 898-1-R10K-F | 73138 | 1.0 | EA |
| R8 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R10 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R11 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R12 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R14 | 530004 | RES,CARB,1W,68 OHM | RC32GF680J | 81349 | 1.0 | EA |
| R15 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R16 | 530068 | RES,CARB,1W,47 OHM | RC32GF470J | 81349 | 1.0 | EA |
| R17 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R18 | 560575 | RES,FILM,1/8W,33.2K,1% | RN55D3322F | 81349 | 1.0 | EA |
| R19 | 560747 | RES,FILM,1/8W,8.66K,1% | RN55D8661F | 81349 | 1.0 | EA |
| R20 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R21 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R22 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R23 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| R24 | 570265 | POT,1T,PC,100K | 63P104 | 02111 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| R25 | 570266 | POT,1T,PC,500 OHM | 63P501 | 02111 | 1.0 | EA |
| R26 | 560748 | RES,FILM,1/8W,4.53K,1% | RN55D4531F | 81349 | 1.0 | EA |
| R27 | 360232 | RES,ARRAY,TFLM,DIP,6.8K | 698-3-R6.8K-F | 73138 | 1.0 | EA |
| R28 | 510068 | RES,CARB,1/4W,4.7K OHM | RC07GF472J | 81349 | 1.0 | EA |
| R32 | 510084 | RES,CARB,1/4W,22K OHM | RC07GF223J | 81349 | 1.0 | EA |
| R33 | 360154 | RES,ARRAY,SIP,22K | 103A223 | 01121 | 1.0 | EA |
| R34 | 360261 | RES,ARRAY,DIP,22 OHM | 898-3-R22 | 73138 | 1.0 | EA |
| R35 | 510064 | RES,CARB,1/4W,3.3K OHM | RC07GF332J | 81349 | 1.0 | EA |
| R36 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R39 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R45 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R46 | 510029 | RES,CARB,1/4W,100 OHM | RC07GF101J | 81349 | 1.0 | EA |
| TP1 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP2 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| TP3 | 250303 | TERMINAL,MINIWRAP POST | T44 | 82893 | 1.0 | EA |
| T1 | 710324 | TRANSFORMER | PC16-640-1 | 08779 | 1.0 | EA |
| U1 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U2 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U3 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U4 | 360360 | IC,MOS,RATE MULT,BCD | 74HCT167 | 16067 | 1.0 | EA |
| U7 | 360159 | IC,TTL,INVERT,HEX | SN74LS04N | 81349 | 1.0 | EA |
| U8 | 360235 | IC,TTL,NAND,4-IN,DUAL | SN74LS20N | 81349 | 1.0 | EA |
| U9 | 360032 | IC,VOLTAGE REG,+5,1A | LM340-5T | 27014 | 1.0 | EA |
| U10 | 360236 | IC,VOLTAGE REG,+10,.1A | UA78L10ACLP | 01295 | 1.0 | EA |
| U11 | 360226 | IC,TTL,COUNTER,DEC,DUAL | SN74LS390N | 81349 | 1.0 | EA |
| U12 | 360237 | IC,OP-AMP,PREC | CA3193E | 18722 | 1.0 | EA |
| U13 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U14 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U15 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U16 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U17 | CIC207-3 | IC,TTL,PROM,256X4 | CIC207-3 | 16067 | 1.0 | EA |
| U18 | 360378 | IC,TTL,COUNTER,BIN,UP/DN | SN74ALS169N | 81349 | 1.0 | EA |
| U19 | CIC207-2 | IC,TTL,PROM,256X4 | CIC207-2 | 16067 | 1.0 | EA |
| U20 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| U21 | 360240 | IC,DAC,8-BIT,.19% | DAC-08EN | 18324 | 1.0 | EA |
| U22 | 360239 | IC,TTL,EXCL NOR,2-IN,OC | SN74LS266N | 81349 | 1.0 | EA |
| Y1 | 250332 | CRYSTAL,10.2M,.005% | HC33U PARALLEL* | 54363 | 1.0 | EA |
| 7 | 160306 | PWB,OSCILLATOR | 4850-750-1 | 16067 | 1.0 | EA |
| 150 | 230057 | SOCKET,DIP,16 PIN | ICO-163-S8-T | 06776 | 2.0 | EA |
| 152 | 240294 | SOCKET,XSTR,4 PIN,TO5/18 | 05-3308 | 83486 | 1.0 | EA |
| 154 | 120027 | DECAL,HIGH VOLTAGE 2X.7" | DANGER | 16067 | 1.0 | EA |

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| J1 | 230057 | SOCKET,DIP,16 PIN | ICO-163-S8-T | 06776 | 1.0 | EA |
| S1 | 240450 | SWITCH,RTRY | 1120-011-1 | 16067 | 1.0 | EA |
| 4 | 160323 | PWB,50/60/400HZ | 4850-705-7 | 16067 | 1.0 | EA |

California INSTRUMENTS

# INSTRUCTION MANUAL
# -SC OPTION

Invertron®

MANUAL ADDENDUM

Model 850T/855T-1SC

## 1.0 GENERAL:

The Model 850T/855T-1C Oscillator is similar to the standard Model 850T/855T-1S (see Section VIII in the standard manual), except for changes required to make the servo input compatible for a 1 volt input with 100% control over the output voltage.

## 2.0 SPECIFICATIONS:

All specifications for the standard Model 850T/855T-1S apply except that servo input is limited to one volt AC and the common mode voltage range is limited to 10 volts AC.

## 3.0 THEORY OF OPERATION:

The theory of operation remains basically unchanged from that of the standard Model 850T/855T-1S.

The changes are outlined below:

The reference voltage for A1-U21 is obtained directly from A1-U10 rather than A1-U12.

The output of A1-U12 is now routed to the A2 phase/servo board thru J1-15. This voltage is fed to the non-inverting input of A2-U14 via A2-R20. This voltage now becomes the reference for error integrator A2-U14.

The DC output of A2-U14 varies the output resistance of A2-U15. The output resistance of A2-U15 forms the input resistor to inverting amplifier A1-U16.

As the servo input voltage varies, the gain of A1-U16 is changed to return the servo input voltage to the value prior to any change.

## 4.0 CALIBRATION:

Calibration is similar to the standard Model 850T/855T-1S with the exception that the servo has a 100% range versus ±10% range.

## 5.0 PARTS LISTS:

4850-415 Add/Delete Parts List
4850-706 Parts List

# California Instruments

CODE IDENT 16067

## PARTS LIST

| REF. DES. | MFG. NUMBER | DESCRIPTION | CODE IDENT | CALICO STOCK NUMBER | ITEM NO |
|---|---|---|---|---|---|
| | 4850-415 | ADD / DELETE - 1 | 16067 | | 1 |
| | | | | | 2 |
| | | | | | 3 |
| | | | | | 4 |
| | 4850-400-1 | STD 850T | 16067 | FINISH GDS | 5 |
| A2 | 4850-706-1 | STD SERVO P.C.B. | 16067 | 4850-706-1 | 6 |
| | | | | | 7 |
| | | | | | 8 |
| | DELETE FROM STD 4850-700-2 (855T) = | | | | 9 |
| | DELETE FROM STD 4850-700-1 (850T) = | | | | 10 |
| | | | | | 11 |
| | | | | | 12 |
| A1R39 | RC07GF100J | RESISTOR 10Ω ¼W 5% | 81349 | 5-10005 | 13 |
| A1R36 | RC07GF100J | RESISTOR 10Ω ¼W 5% | 81349 | 5-10005 | 14 |
| | | | | | 15 |
| | | | | | |
| | | | | | |
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| | | | | | |
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| | | | | | |
| | | | | | |
| | ADD TO STD 4850-700-2 (855T) = | | | | 26 |
| | ADD TO STD 4850-700-1 (850T) = | | | | 27 |
| | | | | | 28 |
| A1R38 | RC07G100J | RESISTOR 10Ω ¼ 5% | 81349 | 5-10005 | 29 |
| A1R39 | NOT USED | | | | 30 |
| A1R37 | RC07G100J | RESISTOR 10Ω ¼ 5% | 81349 | 5-10005 | 31 |
| A1R36 | NOT USED | | | | 32 |
| | | | | | 33 |
| | | | | | 34 |
| | | | | | 35 |
| | | | | | 36 |

MODEL 850T-LS-2850
850T / 855T -10

CALICO P/N 4850-415

ASSY R.D.

TITLE ADD / DELETE

SHT 2 OF 2

| SEQ NO. | COMPONENT ITEM NO. | DESCRIPTION TRUNCATED | ENGINEERING DRAWING NO. | VENDOR | QTY | UM |
|---|---|---|---|---|---|---|
| CR1 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| CR2 | 310227 | DIODE,SWNG,75V,.5W,D035 | 1N4148 | 81349 | 1.0 | EA |
| C12 | 610738 | CAP,TANT,10UF,25V | T362A106M025AS | 05397 | 1.0 | EA |
| C13 | 611059 | CAP,MYLAR,1UF,100V | 160-1.0-M-100H | 55112 | 1.0 | EA |
| C14 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| C15 | 610916 | CAP,MYLAR,.1UF,250V | C280AE/A100K | 80031 | 1.0 | EA |
| J1 | 250339 | CABLE ASSY,FLEX,15COND6" | J-15-24-1-U-6.0 | 08261 | 1.0 | EA |
| J2 | 410289 | CONN,PC HDR,4 PIN | 09-72-1041 | 27264 | 1.0 | EA |
| R18 | 560766 | RES,FILM,1/8W,22.1K,1% | RN55C2212F | 81349 | 1.0 | EA |
| R19 | 560581 | RES,FILM,1/8W,38.3K,1% | RN55D3832F | 81349 | 1.0 | EA |
| R20 | 570257 | POT,1T,PC,25K | 63P253 | 02111 | 1.0 | EA |
| R21 | 360266 | RES,ARRAY,TFLM,DIP,20K | 698-3-R20K-F | 73138 | 1.0 | EA |
| R22 | 570261 | POT,1T,PC,1K | 63P102 | 02111 | 1.0 | EA |
| R23 | 510112 | RES,CARB,1/4W,330K OHM | RC07GF334J | 81349 | 1.0 | EA |
| R24 | 560715 | RES,FILM,1/4W,2.74K,1% | RN60C2741F | 81349 | 1.0 | EA |
| R25 | 560715 | RES,FILM,1/4W,2.74K,1% | RN60C2741F | 81349 | 1.0 | EA |
| R28 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R29 | 510053 | RES,CARB,1/4W,1K OHM | RC07GF102J | 81349 | 1.0 | EA |
| R30 | 510100 | RES,CARB,1/4W,100K OHM | RC07GF104J | 81349 | 1.0 | EA |
| R31 | 510076 | RES,CARB,1/4W,10K OHM | RC07GF103J | 81349 | 1.0 | EA |
| R32 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R33 | 570257 | POT,1T,PC,25K | 63P253 | 02111 | 1.0 | EA |
| R46 | 570257 | POT,1T,PC,25K | 63P253 | 02111 | 1.0 | EA |
| R60 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| R62 | 510005 | RES,CARB,1/4W,10 OHM | RC07GF100J | 81349 | 1.0 | EA |
| U13 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U14 | 360530 | IC,OP-AMP,FET,DUAL | UPC812 | 33297 | 1.0 | EA |
| U15 | 360256 | IC,OPTO,MODULATOR | CLM51 | 03911 | 1.0 | EA |
| XJ2 | 410291 | CONN,PC HSG,4 PIN | 09-50-3041 | 27264 | 1.0 | EA |
| 1 | 160328 | PWB,PHASE/SERVO | 4850-702-7 | 16067 | 1.0 | EA |
| 2 | 410293 | TERMINAL,CRIMP | 08-56-0105 | 27264 | 2.0 | EA |

# Appendix A

| Number | Vendor Name | City | State |
|---|---|---|---|
| 0000A | Electricord | Westfield | PA |
| 0000C | Jackson Bros. | Weedon,Surrey | GB |
| 0000S(28564) | OMCDA (Refac Elect. Corp.) | Winsted | CT |
| 0000W | Milton Roes Co. | Southampton | PA |
| 0000I(527475) | Timco | Los Angeles | CA |
| 000AC | Itac | Santa Clara | CA |
| 000AD(551112) | Plessey (Westlake Cap. Inc.) | Westlake Village | CA |
| 000AG | LaFrance | Philadelphia | PA |
| 000AH(543636) | Jan Crystal | Ft. Myers | FA |
| 000AL(534954) | Data Components, Inc. | Gardena | CA |
| 000AM | Kraus & Naimer | Santa Monica | CA |
| 000AN | Ritz Instrument Transformer | Redondo Beach | CA |
| 000AS | Switches Incorporated | Mt. View | CA |
| 000AY(62643) | United Chemi-Con | Rosemont | IL |
| 000AU | JMJ Technical Prod. Inc. | Kendall Park | NJ |
| 000AV(61037) | Semi Processes, Inc. | San Jose | CA |
| 000AW | Wirco | Chatsworth | CA |
| 000AX(63878) | Apcromics | Mentor | OH |
| 000AY | Silicon Power Cube Corp. | Long Beach | CA |
| 000AZ(612771) | Fujitsu | Santa Clara | CA |
| 000BA(61964) | Omron Electronics, Inc. | Schaumburg | IL |
| 000BB | Kellmark Metals, Inc. | Glendora | CA |
| 000BC | Toshiba America, Inc. | Tustin | CA |
| 000BD(559823) | Electronic Essentials | Woodside | NY |
| 000BE(57856) | Kel-Am | Eldon | MO |
| 000BF(553283) | Berquist | Minneapolis | MN |
| 000BG | Panasonic | Secaucus | NY |
| 000BH | Century Components | Canyon Country | CA |
| 000BI(541863) | Micro Power Systems | Santa Clara | CA |
| 000BJ(106776) | Robinson Nugent | New Albany | IN |
| 000BL(613150) | Beau Products (Vermitron) | Laconia | NH |
| 000BM(917725) | Corelander (Gerrard AJ & Co.) | Des Plaines | IL |
| 000BO | Mitsubishi Electronics Amer. | Sunnyvale | CA |
| 000BP | Silicon Power Cube | Long Beach | CA |
| 000BR | Secme | Bagnolet | France |
| 000BS | Panel Components Corp. | Santa Rosa | CA |
| 00544 | Metal-Cal Div., Avery Prod. | Inglewood | CA |
| 00779 | AMP Inc. | Harrisburg | PA |
| 00853 | Sangamo Electronic Co. | Pickens | SC |
| 00864 | Gee Eng. Co., Inc. | City of Industry | CA |
| 01002 | G.E. Co., Ind. & Pwr. Cap. Dept. | John St. Hudson Falls | NY |
| 01121 | Allen-Bradley Co. | Milwaukee | WI |
| 01139 | G.E. Co., Silicone Prod. | Waterford | NY |
| 01295 | Texas Instruments | Dallas | TX |
| 01961 | Pulse Engineering, Inc. | San Diego | CA |
| 01111 | Spectrol Electronics | City of Industry | CA |
| 02113 | Collcraft, Inc. | Cary | IL |
| 02335 | Fairchild Controls Corp. | Hicksville,LI | NY |
| 02375 | American Insulating Mach. Co. | Philadelphia | PA |
| 02538 | Texas Electronics Co. | Dallas | TX |
| 02660 | Amphenol Corporation | Broadview | IL |
| 02768 | Illinois Tool Works, Inc. | Des Plains | IL |
| 02799 | Use Code 972136 | | |
| 03507 | General Electric Company | Syracuse | NY |
| 03508 | General Electric Company | Syracuse | NY |
| 03797 | Eldema Corporation | Compton | CA |
| 03888 | Pyrofilm Resistor Co., Inc. | Cedar Knolls | NJ |
| 03911 | Claires Corporation | New York | NY |
| 04009 | Arrow-Hart and Hegeman Elec. | Hartford | CT |
| 04099 | Capco, Inc. | Grand Junction | CO |
| 04713 | Motorola Semiconductor Prod. | Phoenix | AZ |
| 04729 | Universal Components Corp. | Green Brook | NJ |
| 04963 | 3-M | St. Paul | MN |
| 05245 | Corcom Inc. | Chicago | IL |
| 05276 | Pomona Electronics., Inc. | Pomona | CA |
| 05397 | Kemet, Union Carbide Corp. | Cleveland | OH |
| 05791 | Lyn-Tron, Inc. | Burbank | CA |
| 05820 | Wakefield Engineering, Inc. | Wakefield | MA |
| 05972 | Loctite Corp. | Newington | CT |
| 06383 | Panduit Corp. | Tinley Park | IL |
| 06514 | Stanton, Wyco Metal Prod. | N. Hollywood | CA |
| 06540 | Amatom Elect. Hardware | New Rochelle | NY |
| 06665 | Precision Monolithics Inc. | Santa Clara | CA |
| 06776 | Robinson Nugent, Inc. | New Albany | IN |
| 06815 | Richco Plastics, Co. | Chicago | IL |
| 07088 | Kelvin Electric Company | Van Nuys | CA |
| 07263 | Fairchild Camera & Instr. | Mt. View | CA |
| 07387 | Birtcher Corporation | Los Angeles | CA |
| 07556 | Umitrack Calabro Plastics | Upper Darby | PA |
| 07633 | Epoxy Prod. Co., Allied Prod. Corp. | New Haven | CT |
| 07707 | USM Corp. (USM Fastener Div) | Shelton | CT |
| 07716 | IRC Incorporated | Burrington | IA |
| 07910 | Dae Cable #15818 | | |
| 08028 | Loctite (Auto & Consumer Grp) | Mtn View | CA |
| 08057 | Spang Ind. (Magnetics Div) | Sandy Lake | PA |
| 08065 | Accurate Rubber and Plastics | San Diego | CA |
| 08214 | Spectra Strip (Amphenol) | Gardena Grove | |
| 08289 | Allan Deibert Co. | Pomona | CA |
| 08353 | Bristol Co. of Canada | Toronoto, Ont | Canada |
| 08730 | Ostby & Barton (Vemaline Prod. Div.) | Warwick | RI |
| 08779 | Signal Transformer | Brooklyn | NY |
| 09214 | GE (Semiconductor Prod. Div) | Auburn | NY |
| 09353 | C & K Components | Newton | MA |
| 09922 | Burndy Corp. | Norwalk | CT |
| 10389 | Chicago Switch | Chicago | IL |
| 11815 | Cherry/Textron (Fastener Div) | Santa Ana | CA |
| 12406 | Elpac Electronics | Santa Ana | CA |
| 12497 | Clarostat Mfg. | Dover | NH |
| 13103 | Thermalloy Company | Dallas | TX |
| 13150 | Vernitron Corp (Beau Prod.) | Laconia | NH |
| 13604 | Sperry Corp. Elec. Systems | Great Neck | NY |
| 13919 | Burr-Brown | Tucson | AZ |
| 14099 | Semtech Corporation | Newbury Park | CA |
| 14604 | Elwood Sensors Inc. | Cranston | RI |
| 14655 | Cornell-Dubilier Elect. Corp. | Newark | NJ |
| 14726 | Hollingsworth Co. | Phoenixville | PA |
| 14752 | Electro Cube, Inc. | San Gabriel | CA |
| 14908 | Electronic Instrument and Specialty Corp. | Stoneham | MA |
| 15238 | ITT Semiconductors | Lawrence | MA |
| 15454 | Ametek ENR (Reedam Div) | Anaheim | CA |
| 15636 | Elec-trol | Norbridge | CA |
| 15801 | Fenwall Electronics | Framingham | MA |
| 15818 | Amelco Teledyne, Inc. | Mt. View | CA |
| 15912 | Amelay | Los Angeles | CA |
| 16067 | California Instruments Co. | San Diego | CA |
| 16758 | Delco Radio Div., Gen. Mtrs. | Kokomo | IN |
| 16954 | Dennison | Framingham | MS |
| 17856 | Silicomix, Inc. | Santa Clara | CA |
| 18076 | Omnpac | City of Industry | CA |
| 18178 | Vactec, Inc. | Maryland Heights | MO |
| 18310 | Comcord Electronics Corp. | New York | NY |
| 18324 | Signetics | Sunnyvale | CA |
| 18613 | Vishay Instruments, Inc. | Malvern | PA |
| 18677 | Semtech Mfg. Co. (Zero Corp.) | Monterey Park | CA |
| 18722 | RCA | Mountaintop | PA |
| 18736 | Voltronics Corp. | Hanover | NJ |
| 19088 | Bomisom Company | Hawthorne | CA |
| 21604 | Buckeye Stamping Company | Columbus | OH |
| 21845 | Solitron Devices (Semi-conductor Group) | Riviera Beach | FL |
| 22599 | Elastic Stop Nut Corp. | Van Nuys | CA |
| 23050 | Product Components Corp. | Hastings-on-Hudson | NY |
| 23936 | Pamotor, Inc. | San Francisco | CA |
| 24011 | ECC | Burlington | MA |
| 24355 | Analog Devices, Inc. | Norwood | MA |
| 24444 | General Semiconductor Inc. | Tempe | AZ |
| 24796 | Pereico, Inc. | Paramount | CA |
| 24931 | Specialty Connector Co., Inc. | Greenwood | IN |
| 24972 | AEG-Telefunken Corp. | Summerville | NJ |
| 25403 | Amperes Electronic Corp. | Bloomerville | RI |
| 25497 | Meter Master | Los Angeles | CA |
| 26405 | Marathon Electric Mfg. Corp. | Bowling Green | OH |
| 26806 | American Ischier, Inc. | Costa Mesa | CA |
| 27014 | National Semi-Conductor Crp. | Santa Clara | CA |
| 27191 | Cutler-Hammer, Inc. | Milwaukee | WI |
| 27264 | Molex | Downers Grove | IL |
| 27335 | B & B Motor & Control Corp. | New York | NY |
| 27556 | (MB Electronic Products | Santa Fe Springs | CA |
| 27683 | Varo, Inc. | St. Garland | TX |
| 27735 | F-Dyne Electronics | Bridgeport | CT |
| 27832 | Hughes Aircraft | Newport Beach | CA |
| 28480 | Hewlett-Packard Co. | Palo Alto | CA |
| 28520 | Heyman Mfg. Company (Heyco) | Kenilworth | NJ |
| 28606 | Echlin Ltd. | Rexdale Ont. | Canada |
| 29379 | Resnord Inc. Tridair Ind. | Torrance | CA |
| 29583 | Busaco Eng. Inc. | El Segundo | CA |
| 30039 | International Components Crp. | Asbury Park | NJ |
| 30161 | Aavid Engineering, Inc. | Laconia | NH |
| 30897 | Derann Company | Sylmar | CA |
| 30983 | Electra/Midland (Kepco/ Electra) | San Diego | CA |
| 31827 | Budwig Mfg. Co. | Ramona | CA |
| 31951 | Teledyne, Inc. | Pittsburg | PA |
| 32293 | Intersil | Cupertino | CA |
| 32559 | Bivar, Inc. | Santa Ana | CA |
| 32997 | Bourns Inc. (Trimpot Div) | Riverside | CA |
| 33005 | Jewell Electrical Inst. Inc. | Manchester | NH |
| 33335 | Logic Dynamics, Inc. | Gardena | CA |
| 33716 | Klingebacher Murray Co. | Los Angeles | CA |
| 33813 | Ducommun, Inc. | Los Angeles | CA |
| 33901 | Caliber Corp. | Irvington | NJ |
| 34218 | Mills Resistor Co. | Los Alamitos | CA |
| 34333 | Silicon General | Westminster | CA |
| 34649 | Intel Corporation | Santa Clara | CA |
| 35007 | Aerovox Canada Ltd. | Amherst NS | Canada |
| 37964 | Linear Technology, Inc. | Burlington, Ont | CAN |
| 44655 | Ohmite Manufacturing Co. | Skokie | IL |
| 45772 | Parker-Hannifin | Clifton | NJ |
| 46384 | Penn. Eng. and Mfg. Corp. | Doylestown | PA |
| 50157 | Midwest Components, Inc. | Muskegon | MI |
| 50522 | Monsanto, Electronic Special Products | Cupertino | CA |
| 50558 | Electronic Concepts, Inc. | Eatontown | NJ |
| 50811 | Mouser Corp. | Santee | CA |
| 51167 | Aries Electronics, Inc. | Frenchtown | NJ |
| 51506 | Accurate Screw Machine Co. | Metley | NJ |
| 51705 | ICO/Rally | Palo Alto | CA |
| 52072 | Circuit Assembly Corp. | Costa Mesa | CA |
| 52745 | Timco | Los Angeles | CA |
| 53076 | Elntex, Inc. | Buffalo | NY |
| 53495 | Data Components, Inc. | Gardena | CA |
| 54361 | Edwards Sheet Metal Works | Fredericktown | OH |
| 54407 | Power-One Co. | Camarillo | CA |
| 55322 | Sastek, Inc. | New Albany | NY |
| 55566 | RAF Electronic Hardware, Inc. | Seymour | CT |
| 56289 | Sprague Electric Company | North Adams | MA |
| 56637 | MCD Components, Inc. | Manchester | NH |
| 57640 | United Chem-Con Corp. | Philadelphia | PA |
| 57856 | Kel-Am, Inc. | Eldon | MO |
| 58474 | Superior Electric Company | Bristol | CT |
| 59730 | Thomas and Betts Company | Elizabeth | NJ |
| 59993 | International Rectifier Semiconductor Div. | El Segundo | CA |
| 60395 | Xicor, Inc. | Milditas | CA |
| 61394 | Seeq Technology, Inc. | San Jose | CA |
| 61515 | Sarmis | Palo Alto | CA |
| 61529 | Aromat Corp. | Mountainside | NJ |
| 61735 | Pulse Engineering, Inc. | College Park | MD |
| 62483 | Demitron Corp. of America | Torrance | CA |
| 62643 | United Chemicon, Inc. | Rosemont | IL |
| 62786 | Hitachi America Ltd. | San Jose | CA |
| 63743 | Ward Leonard Electric Co. | Mt. Vernon | NY |
| 63791 | Star Micronics, Inc. | New York | NY |
| 70318 | Allmetal Screw Prod. Co. | Garden City | NY |
| 70903 | Belden Manufacturing Co. | Chicago | IL |
| 71218 | Bud Industries, Inc. | Willoughby | OH |
| 71279 | Cambridge Thermionic Corp. | Cambridge | MA |
| 71400 | Bussman Mfg. Div. McGraw-Edison Co. | St. Louis | MO |
| 71450 | CTS Corporation | Elkhart | IN |
| 71468 | ITT Cannon Electric, Inc. | Los Angeles | CA |
| 71590 | Centralab Div. Globe-Union | Milwaukee | WI |
| 71707 | Cote-Cal | Providence | RI |
| 71744 | Chicago Miniature Lampworks | Chicago | IL |
| 71785 | Cinch Manufacturing Company | Chicago | IL |
| 71984 | Dow Corning Corp. | Midland | MI |
| 72136 | Elmenco (Electro Motive) | Willimantic | CT |
| 72619 | Dialight Corporation | Brooklyn | NY |
| 72699 | General Instruments | Newark | NJ |
| 73982 | Erie Technological Prod. Inc. | Erie | PA |
| 73138 | Beckman Instruments, Inc. | Fullerton | CA |
| 73612 | Consolidated Electronic Wire and Cable Corp. | Chicago | IL |
| 73734 | Federal Screw Products, Inc. | Chicago | IL |
| 74193 | Heinemann Electric Company | Trenton | NJ |
| 74545 | Harvey Hubbell, Inc. | Bridgeport | CT |
| 74868 | Illinois Condenser Co. | Chicago | IL |
| 74970 | E.F. Johnson Company | Waseca | MN |
| 75042 | TRW Electronic Components | Philadelphia | PA |
| 75382 | Kulka Electric Corporation | Mt. Vernon | NY |
| 75582 | Leviton Mfg. Co. | Little Neck | NY |
| 75915 | Littelfuse, Inc. | Des Plaines | IL |
| 76385 | Minor Rubber Co., Inc. | Bloomfield | NJ |
| 77068 | Pabst Eng. Equipment Co. | Elizabeth | NJ |
| 77122 | United-Carr Inc., Fastn Div | Waterbury | CT |
| 77342 | Potter and Bloumfield Div, AMF | E. Princeton | IN |
| 78189 | Shakeproof Div. IL Tool Works | Chicago | IL |
| 78553 | Tinnerman Products, Inc. | Cleveland | OH |
| 79130 | Johns-Manville Products Corp | Chicago | IL |
| 79136 | Waldes Kohinoor Inc. | Long Island City | NY |
| 79963 | Electric Mfg. Corp. | New Rochelle | NY |
| 80031 | Kepco/Electra | Morristown | NJ |
| 80223 | United Transformer Co. | New York | NY |
| 80294 | Bourns, Inc. | Riverside | CA |
| 80495 | High Voltage Engineering Corp (Anderson Pwr Prod. Div) | Brigston | MA |
| 81095 | Triad Transformer Corp. | Venice | CA |
| 81312 | Winchester Electronics | Oakville | CT |
| 81348 | (Fed. Specs) Promulgated by General Services Administration Washington DC | | |
| 81349 | Military Specification or Commercial Generic Number | | |
| 81541 | Airpax Corp. | Cambridge | MD |
| 81603 | Race Products Co. | Chicago | IL |
| 81851 | Bentley-Harris Mfg Co. | Lionville | PA |
| 82104 | Standard Grigsby | Aurora | IL |
| 82389 | Switchcraft, Inc. | Chicago | IL |
| 82877 | Rotron Mfg. Co., Inc. | Woodstock | NY |
| 82893 | Vector Electronics, Inc. | Sylmar | CA |
| 83330 | Herman H. Smith, Inc. | Brooklyn | NY |
| 83486 | Elco Tool & Screw Corp. | Rockford | IL |
| 83500 | Brady W.H. Co. | Milwaukee | WI |
| 84684 | RCA | Harrison | NJ |
| 84928 | Seastrom Mfg. Co., Inc. | Glendale | CA |
| 87034 | Marco-Oak Industries | Anaheim | CA |
| 88245 | Usaco Div., Litton Ind. | Van Nuys | CA |
| 90201 | Mallory Capacitor Co. | Indianapolis | IN |
| 91506 | Ammat, Inc. | Attleboro | MA |
| 91637 | Dale Electronics, Inc. | Columbus | NE |
| 91662 | Elco Corporation | Willow Grove | PA |
| 91802 | Industrial Devices, Inc. | Edgewater | NJ |
| 91833 | Keystone Electronics Corp. | New York | NY |
| 91947 | National Tel-Tronics | Meadville | PA |
| 92194 | Alpha Wire Corp. | Elizabeth | NJ |
| 93383 | Pentagon Products Co. | Washington | DC |
| 94322 | Sealtec, Inc. | Lester | PA |
| 94698 | Magnecraft Electric Co. | Chicago | IL |
| 95148 | Alco Electronic Prod., Inc. | No. Andover | MA |
| 95303 | RCA | Cincinnati | OH |
| 95354 | Methode Manufacturing Corp. | Rolling Meadows | IL |
| 95546 | Arnold Engineering Co. | Marengo | IL |
| 95987 | Worthesser Company, Inc. | Chicago | IL |
| 96906 | Military Std | | |
| 97525 | Electronic Engineering Co. | Santa Ana | CA |
| 98159 | Rubber Tech, Inc. | Gardena | CA |
| 98191 | Scalecto Corp. | Mamaroneck | NY |
| 98376 | Ixro Mfg. Co. (West) | Burbank | CA |
| 98978 | IERC | Burbank | CA |
| 99817 | Protective Closures Co., Inc. (Caplugs Div) | Buffalo | NY |
| 99217 | Bell Industries, Inc. | Delavan | WI |
| 99742 | Permacell | New Brunswick | NJ |
| 99743 | IMC | Haywood | CA |
| 99800 | Delevan Electronics Corp. | Aurora | NY |

Revision K
June 17, 1986

## ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

## PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA No. to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

## DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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